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THE ROLE OF VERBAL RULES IN THE COGNITIVE PROCESSES OF CHILDREN

by

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ABSTRACT

This dissertation is based on the postulate that speech, in the form of overt or covert verbal rules, is the basis of voluntary behavior, particularly the cognitive processes of problem solving and concept attainment. Although the major role in the regulation of behavior begins with overt speech, the control gradually shifts to the internalized or covert speech system. If extremely complex situations arise, the control of behavior may again depend upon the activated overt speech.

The two major hypotheses deduced from this theory were tested in independent experiments. In the first experiment, which attempted to involve both overt and covert speech directly, the Raven's Matrices was administered to thirty-six Grade IV and V children randomly assigned to three experimental groups. Subjects in the overtly verbalizing group were required to state a reason each time they selected an answer; subjects in the second group were given instructions to covertly verbalize the appropriate rule for each question. The third group, the control, was given only the test publisher's directions. Although the overt verbalizers tended to score slightly higher than the other groups on both the subtests and the total Raven's, the difference was not significant. This finding suggests that these children operate effectively on the basis of their own verbalizations without the added requirements and suggestions of the experimenter. Hence, requiring the subjects to overtly or covertly verbalize is unnecessary and redundant.

In the second experiment, forty-five Grade V children were

randomly assigned to one of three experimental groups in order to examine the effects of three types of treatments on the formation and modification of verbal rules. Two of the groups were trained using a card sorting task; the third group served as a control. The rule-seeking group was reinforced for stating new rules which could be used for sorting; the actual card placement was disregarded. The rule-following group was reinforced for placing the cards in the correct pile, disregarding verbalizations.

The effects of the treatments were examined on problem solving, concept attainment, card grouping, and creativity. The rule-seekers scored significantly higher than the other groups on concept attainment, card grouping, and somewhat higher, though not significantly, on creativity. The rule-followers appeared to have a score profile opposite to that of the rule-seekers in that they scored higher, though not significantly, on problem solving and lower on concept attainment and creativity. These findings suggest that reinforcing rule-seeking behavior has a positive effect on the production of verbal rules and, hence, on tasks of a somewhat divergent or creative nature. Reinforcing rule-following behavior appears to interfere with divergent thinking processes but may have some positive effect on convergent problem solving tasks.

In general, the findings of this dissertation are consistent with the view that speech in the form of overt or covert verbal rules is an important agent in the regulation of one's behavior. The continuing problem to educators is to find effective techniques by which these rules can be modified.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

When Thorndike attempted to explain changes in the behavior of children by means of laws of learning derived from studies of lower animals, he introduced an antinomy which can perhaps finally be resolved. In his attempt to explain the nature of learning in school children, he made the assumption that the process could be reduced to simple tasks resolved by simple animals and still retain the major characteristics of the learning process. By discovering the simple elements, he assumed that more complex processes could be understood by combining the simple elements in the correct proportions. The assumption that the S-R unit is the "molecule" of human behavior still forms the backbone of American psychology. The parameters of reinforcement, incremental learning, extinction, and stimulus-response associations are utilized in even the most complex situations (cf. Osgood, 1953; Dollard and Miller, 1950). Hebb (1960) identifies the problem thus:

> . . . my thesis . . . is that an outstanding contribution to psychology was made in the establishment of a thorough-going behavioristic mode of thinking. But this has been achieved too frequently, only by excluding the chief problem of human behavior. The second contribution must be to establish an equally thorough-going behavioristics of the thought process (p. 736).

Herein, then, resides the antinomy: on the one hand the basic principles of human learning appear so complex that they cannot be readily studied directly; on the other hand, when the situations are simplified to the point where they can be studied, the derived explanations are inadequate for the more significant aspects of human behavior.

The discontinuity between psychological theory and educational practice is often attributed to the anti-intellectualism of the educators. Perhaps the difficulty resides in the discontinuity between psychological theory and human behavior.

The resolution of the antinomy resides, perhaps, in a re-examination of the validity of Thorndike's assumption that the principles of learning applicable to school children and adults can be formulated on the basis of studies conducted with simple animals or even from over-simplified problems with human subjects. Lloyd Morgan (1900) long ago pointed out the danger of explaining the behavior of animals in terms of human attributes. The converse may also be important; it is equally dangerous to attribute to human behavior animal-like characteristics. As Miller, Galanter, and Pribram (1960) point out, "Slowly waxing and waning associations may be useful to characterize a conditioned salivary reflex, but they are not characteristic of human verbal

learnings" (p. 137). Theorizing based and tested on lower species and on over-simplified materials with human subjects has limited applicability to the understanding of human behavior.

This conclusion has some empirical support. Gagné (1962) in a military training situation found that the well-known principles of learning such as reinforcement, distribution of practice and response familiarity were of limited use. Of greater importance was the extent to which the list of procedures was learned verbally. In other words, the speech system was the chief variable, not the classical principles of learning.

Unlike the behavior of rats where a knowledge of the specific stimuli is closely related to the responses produced, human cognitive behavior is extremely variable and unpredictable. Bartlett (1958) observed that unless special precautions are taken, the direction a subject will take in pursuing the solution to a problem involving words is virtually unspecifiable. Human behavior operating on the basis of the language system comes to be somewhat divorced from the actual stimulus situation. Bartlett suggests the word "thinking" is relevant whenever behavior "cannot be wholly accounted for in terms of a response to an immediate external environment" (p. 72).

The problem is, therefore, the discontinuity between human behavior and behavioristic learning theory based on the conditioning model. The origin of the problem, it has been argued, lies in the assumption that the primary principles involved in understanding the behavior of verbal humans can be derived from the study of lower animals.

The solution to the problem, the resolution of the antinomy, it is argued here, resides not in the elaboration of the conditioning model but in the development and utilization of theoretical models which have as a central postulate the executive role of symbolic processes in cognition. Such a theory is Luria's (1961) extension of the second signal system. Other theorists including Osgood, Bruner, Goldstein and Scheerer, and Miller, Galanter, and Pribram have also developed models that deal directly with the higher mental processes.

This dissertation represents an attempt to apply a cognitive theory based on language to one aspect of children's learning, the formation of verbal rules to guide behavior. More specifically, on the basis of a combination of theories regarding the formation and modification of verbal coding systems, two major questions are advanced:

1. Does the overt specification of relevant verbal rules facilitates problem solving?

2. Is the formation and modification of verbal rules subject to the influence of training?

A theoretical and experimental examination of these questions constitutes the body of this dissertation.

CHAPTER II

THEORETICAL FRAMEWORK AND RELATED RESEARCH

In this chapter an attempt will be made to abstract, integrate, and extend certain aspects of three major learning and behavior theories with the object of establishing a general theoretical framework regarding the role of speech in behavior from which testable hypotheses may be derived. The theoretical framework will be drawn primarily from Osgood's general neo-behavioristic model, Bruner's theory of coding systems, and Luria's extension of the second signaling system. These theories were selected because they represent heuristic models which appear to be capable of dealing with the more cognitive aspects of human behavior while maintaining a maximum of scientific rigor. Following the discussion and integration of the relevant aspects of these theories, several other theoretical notions will be examined to find the extent to which they are consonant with the theoretical framework.

Finally, several current experimental findings, particularly those involving verbalization and labeling in concept attainment and problem solving will be critically analyzed in the light of the theoretical framework employed in this thesis. Studies reported in this review were

selected according to two criteria:

1. those which appear representative of the current behavioristic approach to mediation and verbalization in the higher mental processes, and

2. those which provide evidence suitable for assessing the adequacy of the theory or for extending the theory employed in this study.

I. THEORETICAL FRAMEWORK

Osgood's Two-Stage Learning Theory

Osgood (1953, 1954, 1957) presents a comprehensive theory of behavior based on the extension of well-established conditioning principles. The theory is sufficiently general to explain a wide range of behavior from simple perception, to single-stage learning and on to the higher, cognitive processes.

Osgood (1957, p. 81) accounts for perception in terms of the principle of sensory integration which states that the patternings, regularities, and orderings of events in the environment come to be mirrored in the structuring of the central nervous system. That is, stimuli which are repeatedly paired in experience come to be interdependent in perception.

Single-stage learning, or simple conditioning refers

to the process in which a stimulus comes to be associated with a response if it is followed by reinforcement. This level of explanation can be used to account for much of the behavior of lower animals, such as a rat pressing a lever if the act is followed by a food pellet, as well as some human behavior such as a child's learning to say "Thank you!" if this is reinforced by the parent's smile.

The more significant and original of Osgood's notions concerns the higher level of operations at the representational or mediational level. The name "representational" implies a dependence on the symbolic aspects of stimuli rather than the physical, sensory characteristics themselves. The hypothetical construct developed to handle events occurring at this higher level was developed from Hull's (1930) conception of a "pure stimulus act," a symbolic act pertaining to the "not-here" and the "not-now," and from Hebb's (1949) conception of phase sequence which theoretically accounts for responses to ongoing activity in the nervous system rather than to immediate sensory stimuli exclusively.

Osgood's "representational mediational process" has both of these characteristics. He points out:

> Whenever a non-significate stimulus is associated with a significate, and this event is accompanied by a reinforcing state of affairs, the non-significate will acquire an increment of association with some fractional portion of the total behavior elicited by the significate. I call such fractional

> behavior a representational mediation process. It is representational because although now elicited by another stimulus it is part of the behavior produced by the significate itself . . . . It is mediational because the self-stimulation it produced can become associated with various overt responses . . . (1957, p. 92-93).

This mediational model can be used to explain how a stimulus pattern leads to a response. A buzzer may be the sign of electric shock or the sign of food arriving: in each case there will be an anticipatory feeling depending on the response which was originally made to the stimulus. This fractional anticipatory response mediates the appropriate response to the sign. Similarly, perceiving the word "danger" as one is driving down the highway will activate some aspect of the total response previously made to an actual dangerous situation in the form of a representational mediational process. This process in turn leads to some instrumental response such as stepping on the brakes.

Osgood points out that the cognitive processes, including concept attainment and problem solving, operate at this representational level in that they involve symbolic activity. They fit the mediational model in that they involve a class of stimuli that activate a common "meaning" which mediates the appropriate type of response.

Of special significance to the present study is the relationship between sensory signals and representational

determinants in perception and behavior. An individual's reactions depend both on the stimulus information presented and the store of past experiences.

This store of past experiences has an effect in two ways. First, the sensory integrations in the nervous system, which reflect the redundancies of the environment, have the effect of completing sketchy sensory information and of "tuning-up" likely concomitant integrations. Secondly, sensory signals may tend to activate previously established representational mediational processes which account for the "meaning" of the stimuli. Furthermore, feedback from these cognitive states will also influence the perception. In other words cognitions influence perceptions.

Osgood (1957) points out that "identifying or recognizing something requires that sensory signals activate a representational process" (p. 109). Recognition of "thatness" depends on the arousal of a representational mediational process; this process is synomyous with concept identification. Osgood (1953) defines a concept as "a common response (usually verbal) made to a class of phenomena the members of which display certain common characteristics" and then adds, "perhaps, . . . the only essential common characteristic is that a group of discrete situations be associated through learning with the <u>same mediating or symbolic reaction</u>" (p. 666).

Although Osgood suggests that the principles applying at one level of operations do not seem to apply at the other levels, he relies heavily on the parameters of reinforcement, incremental associations and feedback at the representational level.

Finally, speech is not basic to the development of representational mediational processes. To Osgood, any fractional response activated by a cue can be considered as representational. The fractional responses may be motor, affective, or overt or covert speech. All of these types of mediators are established and operate in the same way. They are established by reinforcement and they operate according to the feedback principle. Usually the mediational processes are conditioned into existence and then they may be labeled verbally. The economy of speech is in the fact that verbal labels are more accessible than other characteristics of the representational process; as such they provide a handle by means of which these meaning systems can be manipulated.

Bruner's Cognitive Theory

The hypothetical construct around which Bruner (1956, 1957a, 1957b, 1960) builds his theory is the "coding system" which he defines as a set of contingently related, non-specific categories. The postulation of such a construct

is necessitated by the observation that if we were to respond to each stimulus event as if it were unique, we would soon be overwhelmed by the complexity of the environment. Order is imposed on our sensory experience by relating the stimuli to the suitable category. These categories or classes are of two types, those representing objects or events which can be regarded as identical, and those with objects and events which can be regarded as functionally equivalent. From this point of view, categories can be considered as concepts. These classes or categories from the basis of the first type of coding system. The second type is developed by coding or making sense out of the redundancies of the environment. The first permits an individual to deal with incoming stimuli in terms of a general concept; the second accounts for the expectancies of likely concomitants given one aspect of the stimulus situation. Bruner gives an example of a number sequence: 2, 4, 8, ----, 32, 64. As soon as one is able to see or code that the numbers are powers of two, one is able to provide the missing number. Either type of coding permits one to go beyond the information given.

On the basis of the development of coding systems, Bruner (1957b) accounts for the difference between good and poor spellers. He cites an unpublished study by William Hull in which Grade V children were separated into

high and low groups on the basis of a standardized spelling test. These children were then presented with brief exposures of pseudowords which they were to write down after the card bearing each word was removed. Pseudowords presented were of two types, first-order approximations to English, essentially random strings of letters such as "btfsplk," and third-order approximations to English such as "vernalit," which reflect the probability structure of English very closely. Hull found little difference between the good and poor spellers with respect to the reproduction of first-order words. For the third-order approximations to English, however, the good spellers did much better than the poor spellers. Bruner suggests that the superior performance of the good spellers was attributable to the operation of a coding system based on the transitional probabilities of letter sequences in English. Poor spellers, he argues, tend to learn by rote and consequently would perform poorly on both first and third approximations to English.

Bruner (1957b) summarizes the central notions of his theory as follows:

> We propose that when one goes beyond the information given, one does so by virtue of being able to place the present given in a more generic coding system and that one essentially "reads off" from the coding system additional information either on the basis of learned contingent probabilities or learned principles of relating

> material. Much of what has been called transfer of training can be fruitfully considered a case of applying learned coding systems to new events . . . . This is the cognitive problem in learning. (p. 49)

Although the coding systems appear superficially to be conscious, verbal systems, Bruner maintains that the act of categorizing is often a "silent" or unconscious process. He describes a category as a rule for classifying objects as equivalent but points out that these rules are not necessarily "conscious rules." Categories, nevertheless, are closely related to speech, and the nature of the categories reflect strongly the language and the culture of the people.

Much of Bruner's work concerns the attainment of concepts, that is, the behavior involved in using the attributes of objects and events as a basis of deciding their identity. Concept attainment ". . . refers to the process of finding predictive defining attributes that distinguish exemplars from non-exemplars of the class one seeks to discriminate." (1956, p. 233)

Brown (1956) has extended Bruner's theory to the problem of language, and had stressed the need for distinguishing between linguistic and non-linguistic categories in cognitive operations. He, like Bruner, postulates that conceptual categories originate without verbalization,

that is, as a non-linguistic category. Speech or verbal labels become meaningful when they are co-ordinated with non-linguistic or referential categories. When a label or utterance becomes meaningful it causes us to take account of something beyond itself. Initially, a word may represent, stand for, or signal a non-linguistic category. However, a word is not fully understood nor does it function as a concept until it can be applied to objects or events that one has not previously categorized. That is, a true linguistic category must permit one to go beyond the information given.

In general, Brown considers a category primarily in terms of a non-linguistic entity built up on the basis of redundancies in the environment. Words act as an attribute of these non-linguistic categories, simply another cue capable of activating the category. Of course, a verbal utterance is a category with specific attributes in the speech system. But more important the word is also a selective response elicited by some array of non-linguistic stimuli; it is closely tied to a specific non-linguistic category. This labeling function of speech permits a higher level of operations. Brown (1956) points out:

> The semantic utterance is only one variety of socially functional attribute . . . . Our kin are distinguished by more than kinship terminology. Categories are marked out by the price of Christmas gifts, the occasions for kissing,

> the liklihood of asking for a loan. And so with all categories. They may be marked out by winking, salivating, embracing, and in all cases by speech. Speech differs from these other selective responses in that it is a system constructed from a small set of recurrent elements, the phonemes. It differs also in its breadth of coverage. There is a distinctive utterance for practically every concept we possess and whenever there is not yet such an utterance the man who discovers the lack considers it his first civilizing duty to create one. (p. 279)

To summarize, sense or meaning is made out of a sequence of meaningless random stimuli by means of coding. Related, non-specific categories are called coding systems. Although these processes and constructs are closely related to language their basis resides in the non-linguistic categories of which words function as an attribute. These symbolic, versatile, and parsimonious attributes, Brown claims, play an important role in higher mental process.

<u>Luria and the Second Signal System</u>

Several contemporary Soviet psychologists have been concerned with the role of speech in behavior. Of particular significance is Luria's elaboration of Pavlov's "second signaling system" wherein a word may act as a conditioned stimulus and as such, replace not only an unconditioned reinforcement but also conditioned signals. Pavlov (cited by Simon, 1957) also pointed out that with the appearance

of language "a new principle of nervous activity is introduced, the abstraction and generalization of innumerable signals" (p. 20). This new principle enables the second signaling system to become "the highest regulator of human behavior." (Pavlov, cited by Simon, 1957, p. 20) The existance of the second signaling system means that man's cortical processes are qualitatively different from those of lower animals. Pavlov (Simon, 1957) described these differences as follows:

> In the animal, reality is signalized almost exclusively by the traces they make in the cerebral hemispheres . . . . This is what we too possess in the shape of impressions, sensations, and ideas of the world around us, both the natural and the social with the exceptions of oral and written speech. This is the first system of signals of reality, common to man and animals. But speech constitutes a second system of signals of reality which is peculiarly ours, and is a signal of the first signals. On the one hand, the numerous speech stimulations have removed us from reality . . . . On the other, it is precisely speech which has made us human . . . (p. 20)

Luria (1961) and his colleagues (Liublinskaya, 1957; Luria and Yudovich, 1959) present evidence to support the theory that as children get older their behavior comes to be more controlled by the stimulation they themselves produce. Speech is the most important source of this self-stimulation. Through close social contacts with the mother, the child acquires new ways of dealing with the environment.

Originally the mother controls the child's behavior by pointing out and naming objects and by giving commands to the child. However, after the child acquires speech, the child begins to name actively and thereby control his own perception. By imitation of the orders of the mother he learns how to formulate his own wishes and intentions independently, first in externalized and then in inner speech. These new speech systems enable man to go far beyond the limits of physical experience and simple "respondent" behavior. He is now able to organize active, deliberate, volitional behavior. By incorporating the techniques which had previously proceeded from adults, he becomes capable of actively modifying the stimuli that influences him; by using speech it is possible for him to alter the natural relative strengths of the stimulus elements in a stimulus complex and hence modify his perception.

Luria (1961) describes an experiment illustrating the influence of speech on perception. The experimenter presented complex visual stimuli consisting of a red circle on a grey ground and a green circle on a yellow ground to children from three to five years of age. Each subject was asked to squeeze a balloon with his right hand if the red appeared and to squeeze with the left hand if a green appeared. The correct habit was soon learned. By inter-

changing the color of the grounds of the stimuli it was possible to determine which element of the complex stimuli was dominant. He observed that the color of the figure, the stronger element, was always decisive. The child squeezed with the right hand for the red circle, regardless of the color of the background. The child was incapable of ignoring the figure and responding to the ground.

The experimenter then employed speech via a verbal command to alter the relative natural strengths of the figure and ground. The children were told to press with the right hand for the grey ground and with the left for the yellow ground. Children aged three or four usually continued to respond to the stronger element in the stimulus, the circle. Children aged five to seven were able to react to the background which the verbal command had made the stronger element.

Moreover, by modifying the nature of the verbal instructions to make them more meaningful, the effect of speech in modifying the relative strength of the stimulus elements appeared much earlier. The colored circles were replaced by colored airplanes on the same grey and yellow grounds and the child was asked to squeeze the right hand for the airplane on a yellow ground (because the plane can fly when the sun is shining and the sky is yellow) and with the left hand for the airplane on the grey ground

(because when its rainy the plane cannot fly and has to be stopped). These instructions caused the previously weaker elements, the grounds to become dominant for even the three and four year olds.

These results are interpreted as evidence of the changes in perception brought about by the development of speech. Luria (1961) points out:

> . . . the influence of speech relationships may give rise to fresh functional systems distinguished by the fact that their compound structure includes a system of speech associations and that behavior patterns take on an active volitional character as a result. (p. 10)

Luria then examines the stages in the development of the mental processes under the influence of speech. The first stage involves the labeling or naming function of speech. Liublinskaya (1957) presented children aged twelve to thirty months with red and green boxes, the green being empty and the red containing sweets. The children found it extremely difficult to select the correct box and successful responses tended to be forgotten quickly. However, when the experimenter named the colors of the two boxes, learning was established three times as quickly, correct responses were not readily extinguished and transfer of learning was easily obtained. Luria (1961) concludes:

> By helping to define the required cues, speech substantially modifies the child's perception and permits the working out of a system of stable differentiated associations. (p. 11)

At the next stage, Luria provides evidence of the important role of speech in the process of generalizing visual stimuli. The task involved the squeezing of the balloon with the right hand for a triangle, with the left for a quadrilateral. Testing for generalization to new instances of these figures showed that children aged three to five were incapable of generalizing to the new shapes even when the generalizing name was known. Only in children aged five to seven did speech play a generalizing part. These age limits were reducable by intensive teaching of the concept of triangle and quadrilateral: by the use of tactile cues, and by attending to the defining attributes.

The third stage involves the transition of the regulating aspects of speech from the overt, conscious level at which it was learned to a covert, internalized level where it functions as the basis of the thought process. Luria (1961) cites an electromyographic study to show that speech is latent in all thought but may be brought into play when it is needed for orienting to difficult situations. Speech may even become overt in the fact of extremely serious problems.

With the development of this "new principle in nervous activity" the second signal system, the fundamental laws pertaining to the development of temporary links are modified extensively. Under the first signaling system, a new link

is formed when a conditioned signal is accompanied by constant reinforcement; the link becomes strong only gradually. Once a link is established it is highly specific and a reversal shift is effected only by complete reconditioning. Finally, these links are established to concrete stimuli and their visual relationships; abstract stimuli such as a sequence of signals are not available as conditioned stimuli.

With the development of speech none of the principles just described are completely applicable to the process of forming temporary links. A signal no longer functions merely as a conditioned stimulus but as a signal automatically activating the speech system. A verbal rule or generalization activated by the stimulus modifies the subsequent reaction. Luria (1961) states:

> Once taken into the system of verbally formulated links, the stimulus in question becomes not a mere signal but an item of generalized information, and all subsequent reactions depend more on the system it is taken into than on its physical properties. (p. 22)

The involvement of speech in the formation of these links modifies the laws that were adequate prior to the acquisition of speech. Rather than evolving gradually, the temporary links are incorporated at once into the existing system and regulated by a verbally formulated rule. Secondly, rather than being extinguished by the cessation of reinforcement, a link formulated in a given rule is not dependent on

primary reinforcement; the confirmation of the rule now becomes the reinforcement. Thirdly, reversal shifts, rather than demanding complete reconditioning, are automatic, the reinforced stimulus being changed only once, (for example, saying "Press" instead of "Don't press" for the red light). And finally, by the use of the second signal system it is a fairly simple matter to form reactions to abstract signals.

Although the new system of links is built upon the earlier conditioned links, their introduction provides for a whole new, qualitatively different and specifically human character.

Through what stages of development does this regulatory function of speech pass? The first and earliest stage is characterized by the inability of speech to regulate the child's behavior. Behavior is regulated by the exteroceptive stimuli themselves and by the stimuli arising from the child's own movements. Luria describes an experiment in which a child eighteen to twenty-four months was given a rubber balloon and asked to squeeze it. It was demonstrated that verbal instructions could initiate the desired movement, but could not be used to stop it. The kinesthetic stimulation on the hand, Luria argues, acts as the new signal for continued pressing. However, when the experimental situation was arranged in such a way that exteroceptive "feedback" was

provided in the form of a light coming on by the squeezing response, the light signaled the completion of the act and could be employed to stop the movement. At this level therefore, behavior is controlled by signals generated by the child's own movement acting according to the feedback principle.

In the second stage, the behavior comes under the control of the child's own speech. However, speech still operates in the old way according to the feedback principle, that is, the direct sensory and feedback afferentations regulate the behavior but not the system of meanings associated with these words. Luria describes an experiment in which a three or four year old child was told to squeeze the balloon twice; he could begin to squeeze but instead of squeezing twice he continued to squeeze three or four or more times. The meaning of the word did not regulate his behavior. However, when the child was told to say "Go! Go!" while squeezing the balloon, the child could carry out the instructions of squeezing twice. When the child was told to say "I will squeeze twice," the child accompanied this command with a single protracted movement. Moreover, the child's saying "Don't press" had the same effect as saying "Press;" both verbalizations produced pressing movements. The implication of these experiments

is that although speech regulates behavior at this stage, it does so by means of its sensory, impellant function and not in terms of the generalized meanings of the language system.

The third stage in development of the regulatory role of speech begins at about five to seven years of age. At this stage the impelling, exteroceptive function of speech where speech operates as any other conditional stimulus, recedes into the background and the behavior comes to be regulated by the meaning, significative or representational aspects of speech. Given the command to squeeze twice, the child can squeeze twice.

The final stage involves the reduction of the external forms of speech, and the main role in the regulation of behavior is now "exerted by that higher form of internal speech which constitutes an essential component of both thought and volitional action." (1961, p. 61)

Vygotsky (1962) points out that although the higher mental processes begin with overt speech, inner speech eventually comes to be detached from the specific words by which they were internalized. Inner speech can be considered as thinking in pure meanings. Once established the process of thought is not paralleled by the words themselves; there is no necessary correspondence between the units of thought and the units of speech.

Theoretical Discussion and Summary

The theoretical framework upon which this thesis is based is an integration of certain aspects of the three theories discussed in the preceding section. Osgood's model is important in that it provides a general theory capable of handling a wide range of behavior from perception to cognition while retaining the rigorous behavioristic tradition. From the point of view of this thesis, this latter virtue is also Osgood's limitation in that even the cognitive processes remain tied to the somewhat inadequate principles of feedback and reinforcement. Luria's contribution lies primarily in his emphasis of verbal factors in the regulation of human behavior and on his insistence of a qualitative difference in the principles operative at this higher level. Finally, Bruner's conception of coding systems provides some insight into the organization and interrelationships within these mediators. In so doing he provides the macroscopic units which may be more conducive to cognitive theorizing and to educational practice.

A more careful comparison of these theories reveals several differences. Osgood's distinction between single stage and mediational learning appears parallel to the description of the first and second signaling system. Three major differences exist however. The first involves the

level of explanation employed. One of Osgood's contributions is his attempt to provide an explanation of the mechanics for the operation of the cognitive processes. Whereas Luria deals primarily with the effects of the new level of operations based on speech, not with a description of the actual process, Osgood provides a description of the origin of the mediators, through the conditioning of fractional responses to a sign, and their method of operation, through self-stimulation. In so doing he bypasses the criticism of intangibility frequently leveled at cognitive theorists.

A second distinction between these theories is the basis upon which these higher processes operate. To Osgood, the redundancies of the environment comes to be mirrored in the central nervous system through simple associative pairing. The meaning systems or representational mediational processes are established, likewise, by simple association of sign and significate followed by reinforcement. Once established these mediators may be given a label for convenience.

To Luria on the other hand, the regularities in the environment come to have an influence on behavior primarily because such a verbal category or word exists. Without verbalizing about them it is unlikely that such redundancies

would be perceived. Moreover, rather than labeling a "meaning" with a word, the word is the representation upon which meaning will develop. The social origin of the word precedes the true concept. For example, although the red and green boxes could be discriminated without the appropriate word (by simple conditioning), the process was changed qualitatively by the introduction of speech. Apparently the concept of "redness" was not developed by simply encountering the redundancies in the environment or by reinforced association, it was developed by presenting a word or a symbol upon which the concept could be built. Once the entire speech system is developed the possession of the specific relevant word is not crucial; an individual may verbalize about an object or event and so use his own speech to direct and control his perception of the redundancies in the environment. That is, in human subjects, attention, perception, conditioning, and learning are largely dependent on the presence of appropriate verbalizations.

Bruner's model is more similar to Osgood's on this point than to Luria's. The categories and their coding systems originate as "non-linguistic" categories, operative at an unconscious level. Words may then be attached as an attribute of the concept for manipulative convenience.

This difference between Osgood's notion that concepts

are derived from physical experience and Luria's belief that concepts are determined by social experience--language, has some theoretical significance. If Luria is right the language of the culture will determine the way of thinking about reality much as Whorf (1956) has maintained. Other of Bruner's writings are also supportive of the latter position. In his discussion of the nominalistic view of theory construction he argues that the problem in learning and theory construction is not so much discovering what is "out there" as it is finding new ways to go beyond the information given by describing the same physical reality in terms of different symbolic systems.

The third difference between the theories of Osgood and Luria is in the level at which the representational processes operate. Luria discusses the three levels at which speech, a symbolic process, can operate. The first level consists of speech operating as a mediator but in the same way as any conditioned stimulus, that is, according to the feedback principle. Osgood's account of the origin of the representational mediational processes utilizes these same principles. A fractional portion of the total response is activated by the sign. This fractional response produces self-stimulation according to the feedback principle, which is in turn conditioned to some overt response.

This description of the mechanics of Osgood's system appear to be consistent with Luria's first level rather than the highest level of conceptual operations where the speech information system acts in a new way and the laws applicable to simple conditioning are no longer relevant. Osgood does, however, point out that with use the representational processes become more "short-circuited" until they may be refined to simply a neural change. At this stage, the operation of the system may be altered considerably in that feedback, too, may be so short-circuited as to be essentially bypassed.

Apart from the description of their development, the mediational processes are used to account for many phenomena occurring at Luria's highest level of cognition. These include semantic generalization and the description of a concept or "thatness" as evidence of a mediational process.

In other words, Osgood's mediational processes are analogous to the second signal system. Perhaps because he pursued the formation of mediators from physical rather than social experience, he did not hypothesize as did Luria that these mediating processes operate in a way fundamentally different from simpler conditioning.

If Luria is correct, non-linguistic concepts or

categories have at one stage of their development been verbalized. Lower animals have, therefore, no true concepts. Similarly, "rules" operating unconsciously were conscious and likely verbalized at some stage of their development. As Vygotsky (1962) pointed out, when the control of behavior shifts to internalized speech, the thought processes no longer have an isomorphic relation to the words by which they were internalized. Their unconscious operation does not imply they originated unconsciously. As Razran (1960) has shown, as a habit becomes well established it tends to recede from consciousness.

Bruner's major contribution, from the point of view of this thesis, is his insight into the nature of the complex information system which Luria suggested formed the basis for the control of behavior of verbal humans. Bruner suggests that related concepts are integrated into a coding system which could be described as hierarchy of mediators of increasing generality. For example, the concept of animal mediates the concepts of horse, centaur, and amoeba. More generic coding systems which are capable of carrying more information are referred to as the "structure" of subject matter and are best represented by a general theory. Although Luria does not extend his theory to cover these conceptual systems, the two theories are not incompatible.

The major modification that Luria's theory would suggest would be to emphasize the role of speech in the establishment and operation of coding systems. Hence, the term "verbal coding system" as used in this thesis stresses both the relationships among concepts and their dependence on overt or covert verbalization. This emphasis would suggest the importance of an adequate verbal system as a basis for any cognitive endeavor. Multi-factors in intelligence may correspond to the existence of symbolic coding systems relevant to particular types of operations. Similarly, to educators, each subject matter area may depend on the development of adequate verbal coding systems basic to that subject.

For the purpose of this study, the basic cognitive structures of the adult human are conceived as verbal coding systems or verbal rules by means of which an individual interprets his world and controls his behavior. This theory and its corollaries relevant to this study could be summarized as follows:

1. The learning and behavior of sub-human species and pre-verbal humans operate at the level of the first signal system or simple conditioning. As such it is determined by the classical parameters of reinforcement, incremental associations, extinction and specificity of learning.

2. In early childhood labeling responses are learned. At this level speech operates as a new type of sign to which

various associations may be conditioned. Speech operates as a new type of exteroceptive stimulus. It operates on the feedback principle much the same as muscular feedback. At this stage learning and behavior control operate within the classical parameters described above.

3. At about five and one-half years of age the function of speech changes qualitatively. Speech comes to operate as a complex informational system dependent on the representative or semantic aspects of speech, rather than on the physical characteristics and the interoceptive feedback from the words themselves. The specific features of this level of development are as follows:

a. The classical principles of learning are no longer adequate. The function of reinforcement changes from that of strengthening S-R associations to that of information, serving to confirm and infirm hypotheses or rules.

b. Behavior is no longer simply a matter of reaction to stimuli but involves the active manipulation and organization of stimulus events. Thus the individual exercises some control in processing the information necessary for the formulation or modification of the rules governing his behavior.

c. The most effective means for changing behavior at this level involves the modification of the rules or

the information upon which rules are based. By implication, the technique of shaping responses through reinforcing successive approximations (Skinner, 1938) loses much of its value.

d. At this level, verbal mediation enters into all cognitive processes and, thereby, gives human problem-solving behavior its unique characteristics.

e. Although the verbal systems begin at an overt level, in one's own or another's speech, as they become well established they become implicit and eventually form the material basis of "wordless thought." With the development of covert or implicit speech the thought processes lose their isomorphic relation to the words formerly employed to convey them. Hence, thoughts may not be readily transferred back into overt speech.

f. ". . . internal speech . . . is latent in all thought, becomes activated when difficulties arise, and is vital for orientation to difficult situations; it passes back into externalized speech only in the fact of especially grave difficulties." (Luria, 1961, p. 15)

4. Since the rules guiding behavior are based on speech, the rules concerning the formation and modification of these rules are presumably also based on speech and subject to verbalization. They may be considered as higher

order verbal rules which operate in the same way as lower order verbal rules.

5. Verbal rules or concepts which are related may be organized into more generic verbal coding systems. These generic systems correspond to the "structure" of a subject matter area in that they provide a systematic symbolic system that can integrate and "make sense" out of a broad range of phenomena.

II. RELATED RESEARCH

Theoretical Studies

In this section several theoretical models will be examined to find the extent to which they are in agreement with the theory developed in this study.

Many extensive works have been produced on general theories of the higher mental processes. From a philosophical point of view, Langer (1951) suggests that the new philosophical frontier resides in the examination of symbolism and the symbolic processes. Language, she suggests, is the free accomplished use of symbolism, the representation of articulate conceptual thinking. Without language, explicit thought does not appear. The new "key" is symbolism; in it can be gained many new psychological and philosophical perspectives.

Goldstein and Scheerer (1941) in their theory of concrete-abstract behavior suggest a sharp distinction between simply reacting to stimuli and the higher levels of behavior control. Concrete behavior refers to the unreflective reaction to some dominant aspect of the stimulus. They point out that the higher level, the abstract level, is not simply one of greater complexity; it is generically different from the concrete. The chief character of this new level is the appearance of conscious will, a factor that is reflected in object sorting tasks. Whereas normal adults can group objects in a variety of ways, account for the principle of their sorting, and voluntarily shift the conceptual basis of their sorting, severely brain-damaged patients and young children respond only to the immediate sensory impressions.

In a similar vein, Miller, Galanter, and Pribram (1960) attempt to deal with the more complex aspects of human behavior through the use of a computer model. They assert that human behavior is qualitatively different from that of lower animals and hence cannot be adequately represented by stimulus-response models. Central to this higher level of behavior is the human capacity to create and manipulate symbols. They state:

> . . . it becomes possible for man to use language in order to rearrange the symbols and to form new Plans. We have every reason to believe that man's verbal abilities are intimately related to his planning abilities. And, because human Plans are so often verbal, they can be communicated, a fact of crucial importance in the evolution of our social adjustments to one another. (p. 38)

The Plans as described by Miller, Galanter, and Pribram are comparable to both Goldstein's "abstract" behavior and the conception of verbal rules as employed in this thesis. They all deal with the peculiar human ability to guide and regulate one's own behavior through the use of language.

One other theoretical notion of particular relevance to this thesis is Miller, Galanter, and Pribram's concept of Metaplan, a higher level Plan which has to do with the formation and modification of more specific Plans. From the point of view of this thesis it would suggest the possibility of verbal rules controling the acquisition and operation of more specific rules.

Mowrer (1960) in an extensive review of the literature suggests that verbalization or labeling in itself is not the distinctive feature of language but rather it is predication, doing something with the concept, that constitutes the defining character of articulated human language. This distinction complements the model employed in this thesis in

that the ability to form verbal rules to guide one's behavior may be a function of the ability to manipulate concepts by predication. In other words, the important advancement resides in being able to say "Blow nose" rather than to merely label "nose."

The dissatisfaction with simple conditioning models shown by cognitive theorists working within general psychology is also manifest by some educational psychologists. Ausubel and Fitzgerald (1962) for example, suggest that school learning requires the incorporation of new concepts and information into a cognitive framework. These cognitive structures closely resemble the verbal coding systems hypothesized in this thesis. Ausubel and Fitzgerald provide some evidence that new responses rather than interfering directly with the S-R components, affect the relevant aspects of the cognitive structure. Using a proactive inhibition research design, they demonstrated that meaningful learning and retention of a passage on Buddhism was not interfered with by prior learning on Christianity. As Luria pointed out, the principles applicable under the first signaling system are not adequate for learning in verbal humans.

One very interesting and productive approach to the problem of the higher mental processes has been the studies on reversal-nonreversal shifts. Kendler and Kendler (1962)

review several studies conducted in this area along with their own programatic research. The major theoretical notion is the phylogenetic and maturational transition from stimulus-response learning to mediated learning. They maintain that mediated links form the basis of problem solving in adult humans.

The basic research design employed in these studies is the comparison of reversal and non-reversal shifts. The stimuli consisted of cups differing on two dimensions (size and brightness). In the first discrimination subjects were rewarded for responses to one dimension (for example, always selecting the large cup) while ignoring the other dimension. After learning the required discrimination the subject is forced to shift to another response. In the reversal shift the subject is required to literally "reverse" his responses within the same dimension (for example, always select the small cup). In the non-reversal shift, the subject is required to select on the basis of the other dimension (for example, select the black cup).

They find that whereas college students can perform the reversal shift more easily than the non-reversal shift, rats and small children (nursery school age) execute the non-reversal shift more easily. The authors conclude that

the reversal shifts are easier for human adults because these subjects utilize the same mediating process both before and after the shift. Animals and preverbal children, having no mediating process find the non-reversal shift easier because they respond at an S-R conditioning level. A non-reversal shift is more easily conditioned because it is not necessary to extinguish one response prior to conditioning the other as would be necessary in the reversal shift.

The authors then conducted a series of studies to find the point of transition from single stage S-R learning to mediated learning. This transitional point was found to occur at about five years of age; about one-half of these children responded in each of these ways. Furthermore, when split into fast learning and slow learning groups, the former was found to respond in a mediating fashion, the the latter according to the single-stage S-R model.

It is important to notice that this transition corresponds to the notion of the transition from the sensory signalizing properties of the word operating on the feedback principle to the representational symbolic function of speech as developed in this dissertation.

In further exploration of the relationship between the hypothesized mediational process and verbal behavior

the authors modified the design slightly and had groups of four and seven year olds attach verbal labels to the answer in the training sessions. The subjects were then tested on the reversal shifts in such a way that the labels could be relevant or irrelevant. A control group working without labels was included. The results showed that the relevant label facilitated solution in the four year olds but had no effect on the seven year olds. The irrelevant labels, however, hindered the seven year olds even more than the four year olds.

These findings, although they presented some problems to Kendler and Kendler, could be predicted on the basis of the theory developed in this dissertation. Presumably, the relevant verbalization had a facilitatiory effect on the four year olds and not the seven year olds because the older ones mediate regardless of instructions. That is, the seven year olds correctly verbalize the dimensions; hence overt verbalization has little advantage. The four year olds on the other hand, are less likely to respond mediately without the experimenter demanding verbalization.

The fact that irrelevant verbalizing had a more pronounced effect on the older children is perhaps due to the important role speech occupies in the older child. Children's verbalizations, Luria points out, do not effectively

control behavior until after about five and one-half years. Hence, irrelevant verbalization does not have the disorganizing influence on preverbal children that it does have on verbal children.

This transitional notion is also documented from the area of intelligence measurement. Anderson (1960) points out that what is being measured by an intelligence test is closely related to the capacity of the organism to code, classify, and symbolize his experience. Since this ability cannot emerge until the development of symbolic processes, primarily language, intelligence test scores prior to this transition are only marginally associated with later intelligence scores. This is documented by the fact that the correlations between subsequent tests are very low prior to age five, and by the fact that children's intelligence scores correlate highly with their parents' intelligence scores only after the age of five.

Although Piaget's (1947) theory abounds with transitions, the one particularly relevant to this review is the transition from sensory-motor intelligence to conceptual intelligence. Piaget points out the fundamental differences between these two levels of operation as follows:

> . . . acts of sensory motor intelligence can themselves only be reduced to a succession of states, linked by brief anticipations and reconstructions, but never arriving at an all

> embracing representation; the latter can only be established if thought makes these states simultaneous and thus releases them from the temporal sequence characteristics of action . . .
>
> In the second place, . . . an act of sensory motor intelligence leads only to practical satisfaction, . . . and not to knowledge as such.
>
> . . . sensory-motor intelligence deals only with real entities . . . with very short distances between subjects and objects . . . . Thought alone breaks away from these short distances and physical pathways . . . (p. 120-121)

The description in this dissertation of the change from speech operating according to the feedback principle to its representational function is obviously compatible with that provided by Piaget.

All of these theoretical views support the theme, basic to this dissertation, that with the development of language, a qualitatively different type of explanation of behavior control is required. Rather than speaking in terms of conditioning a stimulus and response association, the central notions become verbal rules or verbal coding systems; in the place of incremental trial and error learning, there is meaningful insightful learning; in the place of reinforcement there is confirmatory information; and rather than experimentally include or exclude verbal mediation, it is automatically involved in virtually all human behavior.

Experimental Studies

It is the purpose of this section to examine some specific experimental studies which may further elucidate the formation and operation of verbal rules particularly as they apply to concept attainment.

As has been pointed out above, adult humans operate conceptually on the basis of internalized or implicit speech. Behavior is regulated by means of verbal rules. As these rules become well established they become covert and often difficult to retrieve verbally. For the purpose of this study concept formation is defined as the process of forming a verbal rule for classifying sensory information. As this rule becomes well established it is replaced by a single word which we normally call a concept. Whereas the original rule may be "That hairy, brown, meowy thing," when it becomes well established this clumsy rule is replaced by the word "cat". A group of related verbal concepts is called a verbal coding system.

One of the early studies of concept attainment was carried out by Heidbreder (1946). In this experiment the concept materials did not have identical elements as earlier studies (Hull, 1920) had employed, rather they had common verbalizable meanings. For example, all "trees" were to be called MULP. The experiment consisted of learning the list

of nonsense syllables to a series of specific drawings. Following the learning to some criterion the subjects were transferred to a new list of drawings to which the same set of nonsense syllables was applied. This procedure was repeated for five lists of drawings. Scores were taken as the list on which the subject could first anticipate the nonsense syllable accompanying the drawing. The major finding was that concepts involving concrete objects were learned more easily than either spatial forms or abstract numbers.

One difficulty associated with this type of approach is the fact that different exemplars convey an uncontrolled amount of information. It is difficult to conclude with certainty one type of concept is easier than another if the one concept was formed on the basis of more relevant and less irrelevant information. If real differences in difficulty of attaining different types of concepts does exist, it may be attributed to the availability and clarity of the appropriate verbal coding system.

Of some importance to this review are the studies on pathological cases reported by Goldstein and Scheerer (1941) and Hanfmann and Kasanin (1937). Their general conclusion was that although mental patients may respond to identical elements of color or shape, they generally cannot combine

two concepts (color and form) or shift readily from one to another. A patient does not possess a general concept such as that of triangularity. This suggests that they, like preverbal children and lower species cannot utilize the highest aspects of speech, the representational or semantic aspects, but rather operate on the basis of concrete objects and speech operating according to the feedback principle.

Much of the recent research in concept formation has failed to utilize the highest levels of thought operating on the basis of verbal systems. They are based on the Hullian conception of incremental associations between stimulus and response produced by reinforcement. Even so-called mediational theories remain closely tied to the S-R principles to which they are etiologically linked.

Underwood and Richardson (1956a) have designed materials for the study of verbal concept formation. The task consists of responding to a series of common nouns with some descriptive adjective. For example, the concept "white" may be the common response to the nouns chalk, milk, snow, and moon. To increase the difficulty of the problem six concepts are solved simultaneously and the instances are presented in four-second intervals.

The limitation of such an approach is that the actual

problem of attaining the concept is rather simple. The variables that lead to the production of a good learning curve, presenting six concepts simultaneously and rapid presentation, are irrelevant to the actual problem. This type of task is therefore, somewhat limited in its ability to throw light on the process and parameters of concept attainment.

A somewhat more sophisticated approach with a more elaborate theory but still limited by the notions of conditioning theory, is the verbal mediational approach to concept formation.

Goss and his associates (Fenn and Goss, 1957; Carey and Goss, 1957; Goss and Moylan, 1958; Goss, 1961) have reported a series of investigations and some theoretical analysis of the problem of verbal mediation and concept formation.

The tasks involved the sorting of blocks constructed to vary in four dimensions with two values in each dimension. The problem was to sort these blocks into four groups on the basis of two of these attributes while ignoring the other attributes. To introduce verbal mediation, subjects were pre-trained by the paired-associates technique to respond with a word or nonsense syllable to a subset of blocks. These same subsets of blocks were subsequently considered

as groups for conceptual sorting. That is, the four blocks that were later to be sorted into the group tall-large were given a common label "tall-large" or "dax" in the pre-training; the other three groups were similarly handled. Goss and his associates' findings consistently showed that the pre-training of appropriate verbal mediators facilitated subsequent conceptual sorting and that the sorting accuracy "was directly related to the degree of mastery of associations between initiating stimuli and presumed mediating responses." (Goss, 1961, p. 269)

Presumably, the conclusion one is to draw from these studies is that the establishment or the "tuning-up" of the appropriate mediational process facilitates or assists subsequent concept formation. A second look at the design leads one to notice that any concept formation in these experiments was accomplished <u>during the training sessions</u>; subsequent block sorting acts only as a criterion test of the extent to which the relevant concepts have been established. If the subjects learned that tall-large blocks, regardless of their other attributes, go together with the same label, they have attained the concept; they have solved the problem. The block sorting is unnecessary, automatic, and irrelevant (unless the subject fails to see the continuity between the training and testing, or if he decides to play by his own rules).

The first half of the problem, the learning of the common label to the to-be-grouped objects is somewhat similar to that of Underwood and Richardson (1956) except that the answers are given to begin with. The problem for the subjects could be considered as learning to anticipate which of the attributes were to be ignored and which attended to in the labeling of the blocks. If this contention is valid it would suggest that if the subjects did learn the appropriate responses perfectly, they would perform without error in the block sorting ((provided they were "good" experimental subjects. (Orne, 1962)) Moreover, it would suggest that merely telling the subject that he should notice these attributes and ignore the others would enable him to respond without error, even without the training session.

Both of these hypotheses are supported by Goss's studies. With a low degree of mastery of the appropriate labels, the subjects sorting only approximates the categories chosen by the experimenter; they have not yet had sufficient information to find out what the desired performance was. A higher level of mastery produced better sorting. However, none of the subjects were trained to complete mastery. On the basis of the curve representing the relationship of mastery to sorting (Goss and Moylan,

1958), one would hypothesize that complete mastery of the pre-training task would produce the errorless grouping, obviating the criterion task. Support for this hypothesis is given by the finding (Goss and Moylan, 1958) that when subjects were merely given appropriate instructions their behavior was far superior to even the trained groups; they approached errorless performance.

One is led to the conclusion that these experiments do not really examine the existence, nature, or the role of verbal mediating processes. The results are perhaps an artifact resulting from an ingenious experimental design.

One further line of evidence regarding the inadequacey of these experiments and to some extent the underlying rationale is the effects of labeling the desired group with a nonsense syllable. These studies make the unlikely assumption that without the nonsense syllable, the subjects will not verbally mediate. Although the data are not presented it is unlikely that the untrained, control group sorted randomly; they likely followed fairly well articulated hypothesis formed on the basis of mediation. They were "wrong" because the experimenter had chosen some other sorting groups. It should not be difficult to show that the way the subject had learned the correct association was by noticing or saying to himself, "Tall blocks are

called 'civ'." In other words, the subject verbally mediates to set up verbal mediators. The nonsense syllable makes the problem more difficult because the subject not only has to learn the attributes of the group but also a nonsense syllable to pair with it. It is possible that both types of pre-training simply provide information to the subjects as to the grouping desired by the experimenter; simply telling him is the most effective, letting him find it for himself by presenting him with all the instances of each group is quite effective, and giving him partial information helps slightly in the subsequent tasks. This interpretation corresponds to the point made by Orne (1962) who in discussing the limitations of experimental designs in psychology in general suggested:

> The subject's performance in an experiment might almost be conceptualized as problem-solving behavior; that is, at some level he sees it as his task to ascertain the true purpose of the experiment and respond in a manner which will support the hypotheses being tested. (p. 779)

If these criticisms are legitimate, what is the problem and wherein does one look for the answers?

The problem appears to reside in an assumption made by Goss and some other "neo-behaviorists" that adult human subjects do not verbally mediate unless you provide the mediators. That is, he implicitly assumes that behavior does

not operate on the basis of verbal mediation unless you make a special point to involve it.

This assumption does not correspond to the observed facts. As both Gagné (1959) and Shipstone (1960) point out, even when a human is supposed to be responding randomly, he typically adopts a sequence of small strategies or rules to follow. An example of this is the familiar "gambler's fallacy," that is, expecting the probability of A to increase because of a succession of B's. The classical experiments on perceptual recall by Hebb and Foord (1945) and Carmichael, Hogen, and Walter (1932) again show the importance and generality of verbal mediators. In the area of motivation Schacter and Singer (1962) showed that motivation is a function of cognition and Albert Ellis (1962) asserts that verbal statements determine emotion. Gibson's (1963) recent findings on active touch may be interpreted as evidence that behavior is controlled by the hypotheses of the toucher. The testing of these hypotheses or verbal rules may be responsible for the active character of the touching process. As Luria (1961) pointed out and empirically demonstrated, in human subjects, once the speech processes are developed, behavior operates on the basis of speech; it is virtually impossible to modify human behavior without involving verbal mediation and the speech system.

Spielberger and Levin's (1962) demonstration of the necessity of awareness of the relationship between the behavior and the reinforcement before conditioning could take place again shows the basic nature of cognitive processes in even the supposedly simple processes of conditioning.

In one of Goss's own studies (Carey and Goss, 1957) the authors came upon evidence that supports the distinction between adult, verbally mediated behavior and preverbal behavior. In what was designed to be a replication of their experiment, nursery school children were trained and tested on simplified materials similar to those described above. Several interesting findings resulted. First, these preverbal children had a great deal of difficulty learning the label common to the to-be-sorted group. Only two subjects in each group were trained up to criterion. The generalized label was extremely difficult for preverbal children. As Luria reports, it requires intensive training to build up a generalized concept in children under five or six years of age. Hence, only a few subjects were capable of the generalized name; probably the most precocious children.

Secondly, the training had no effect on the first sortings after training. Initial sorts were performed at a chance level. It was only with continued reinforcement

(and training) that subjects began to make some gains in the block sorting task. Other children with less training on the appropriate groupings showed no gains.

Finally, the authors point out that whereas the older Ss required no reinforcement, these children required continued reinforcement. These children are presumably still operating according to the feedback principle and hence are dependent on reinforcement. With the development of the higher, representational quality of speech, reinforcement is relatively unimportant. In general, the behavior exhibited in this experiment is not continuous with that observed in older subjects; a point well documented in this dissertation.

The naive assumption that verbal mediation can be employed in the experimental group and bypassed in the control group is not limited to Goss. Paired-associate psychologists are perturbed by the fact that their subjects verbalize and "think;" when they finally do design a task that precludes mediation, they are surprised to find that the task is impossible. (cf. Cofer, 1957)

The problem is, therefore, not to show that mediation is better than no mediation. If that is the intention, studies like those of Luria (1961), Liublinskaya (1957), and Kendler and Kendler (1962) will have to be done with preverbal children. Once the speech system is developed

at about five and one-half years of age, verbal mediation is automatic; it cannot easily be excluded even by devious experimental designs.

Several experimental studies more in line with the theory presented here have been reported.

In an early study by Kuenne (1946) the development of verbal control of transposition behavior was studied. In this experiment forty-four children with mental ages from three to six years were allowed to select one of two boxes labeled with two different sizes of white squares. There were three sets of boxes used in the experiment; each set varied in the size of the white squares on the boxes. The training boxes were labeled with large squares of different sizes in the ratio of 2:1. The boxes used for testing the transposition maintained the same ratio of sizes but smaller absolute areas, the first pair of medium areas, the second pair of small areas. Selecting the smaller box in each pair was rewarded by finding a small toy; the larger box was locked. Kuenne's findings revealed a highly significant relationship between mental age and the occurrence of the far transposition and a low relationship between mental age and the near transposition. That is, older children did about equally well on both medium and small sized cues after training on the large cues wheras younger children did much better on the middle

sized cues than on the small ones. Kuenne concludes, ". . . with the development in older children of the capacity to employ verbal responses in such behavior situations a shift occurs to a verbal type of control." (p. 449) The near transposition can be handled by stimulus generalization; the far transposition requires a verbal concept.

The limitation of this study is the difficulty in attributing the change in behavior from young to older children to language specifically rather than to some maturational factor.

This limitation is removed in the study by Liublinskaya (1957). Young children were required to abstract the color from the pattern of butterfly wings and then to select the butterfly with a similar pattern from a number shown. The experimental group was given a verbal label for differentiating the patterns such as spots, stripes, and net; the control was given only practice on the task. At first the subjects attended only to color; after the names were given, subjects were capable of making the required discriminations. Liublinskaya concludes that the introduction of language permitted the reorganization of perceptual differentiation and that with this emerged the thinking process of comparison. He adds, "Spatial connections can be perceived only by perceptual contemplation,

but even so they are only understood when given a verbal designation." (p. 202)

Liublinskaya goes on to describe another experiment operating at a somewhat higher level in which subjects were to give a description of a picture. One group was taught prepositions and adjectives denoting position and spatial relations between objects. On the final task the control group responded with simple naming and labeling; they could not interpret the whole picture. The trained group reflected the whole situation represented in the picture. They stated the content correctly, expressed the relationships and gave suitable generalized names for each picture. Liublinskaya concluded that the development of a child's speech and the range in its structure are directly related to the higher level of thinking attained.

When it comes to verbal labeling and verbal mediation in adult human behavior, the effects are harder to specify. Since all adult humans operate on the basis of verbal mediation, the design cannot usually preclude verbalization. The effects of encouraging overt, specific verbalization however, is not entirely clear.

Brown and Lenneburg (1954) showed that the recognition and identification of color patches was directly related to their codability. If the appropriate verbal concept is available, learning and retention is greatly

facilitated.

The facilitating effect of appropriate labels, that is, labels that draw attention to the relevant aspect of the stimulus, is well documented. Campbell and Freeman (1955), Heidbreder and Zimmerman (1955), and Braun and Bendig (1958) show its facilitative effect on perceptual learning; Herman, Lawless, and Marshall (1957) show its influence on the reproduction of visually perceived forms. They also point out that labeling becomes superfluous if subjects are told to attend to the relevant aspect of the stimulus, the form. In terms of the theory employed in this dissertation, overt speech is redundant if appropriate covert speech is involved.

Rasmussen and Archer (1961) used labeling pretraining of nonsense words to eight or ten sided random shapes by the paired associate technique. They conclude that labeling pretraining did not beneficially affect concept attainment. This finding may be due to the relatively "meaningless" materials, but more likely it is due to the fact that the implicit verbalization and the verbal label was irrelevant to the concept task. The latter argument is supported by Rasmussen and Archer's finding that the verbally pretrained group did better on the problem where shape, the previously labeled aspect, was relevant.

Apart from specific labeling, overt verbalization in general, disregarding its specific content, appears to have some beneficial effects on the solving of complex problems. Weir and Stevenson (1959) involved overt verbalization in a discrimination task. Instructions to name the correct responses produced more rapid learning over all age groups from three to nine years.

More recently, Gagné and Smith (1962) required their subjects to give an overt verbal reason for every response during the solution of a series of increasingly difficult yet similar tasks. The results provided striking evidence of the incremental beneficial effects of verbalizing on progressively more difficult tasks. Verbalizing subjects required less time and made fewer errors. The content of the verbally formulated rules was apparently unenlightening. However, it led to the more adequate expression of the principle at the end of the experiment.

In line with the theory presented in this review, it would be assumed that the facilitatory affect of verbalization was not due to the fact that it make him operate by way of his verbal coding systems; the subject will verbalize regardless. The effect may be due to the fact that, according to Luria, overt speech becomes necessary in orienting to very difficult situations. As Novikova (1961) reports, when speech movements were partially

excluded, there was some interference with complex forms of cortical activity. This interference is unlikely if subjects are permitted to verbalize.

Only a few studies have dealt directly with the role of verbal rules in human behavior. Shepard, Hovland, and Jenkins (1961) in an experimental study of learning different types of classifications conclude, "The results suggest that, in addition to abstracting the relevant dimensions Ss learn any given classification by formulating a rule for building that classification up out of . . . simpler . . . classifications." (p. 39)

Verplanck (1962) has attacked these verbal processes directly. He carried out a series of experiments to find the relationship between verbal and other behaviors. The subject of study was the verbal operants which he calls "notates," a discriminated verbal response. These are essentially "rules" which subjects use in a wide range of situations including concept attainment and problem solving. As such they resemble mediators or hypotheses, but, as Verplanck points out, "Unlike 'mediating . . . processes' these verbal behaviors are not theoretically inferred, or indirectly manipulated, but rather are subject to direct experimental investigation." (p. 1)

The task required the subjects to sort multi-attribute

cards into two piles on the basis of some rule. One group was reinforced for the correct rule, the other for the correct placement of the card, irrespective of the rule. In both cases the reinforcement followed the placement. Verplanck found that under differential reinforcement, the statement of a rule could be dissociated to a degree from the placement behavior which the rule apparently directed.

Recognizing that even if no overt speech accompanied the behavior, the subjects were still operating on the basis of rules, Verplanck subjected these covert rules to the same type of reinforcement as in the first experiment. Reinforcement had an effect on the covert rules similar to that on overt rules. He points out that only by devious means, as by distraction, can one prevent the subject from verbally responding to the significant variables in an experiment.

Of final significance to this study was Verplanck's finding that confirmation of the rule acted as a reinforcing stimulus. Social reinforcers were irrelevant. However, if the social reinforcement contradicted the confirmatory reinforcement, some individuals were primarily controlled by social reinforcers whereas others heeded particularly the non-social confirmations.

In general, the most significant findings in these studies from the point of view of this review is the

importance of verbal rules in the higher mental processes. The more specific findings such as the subjects "finding the rule" even when not instructed to do so, the insightful, all-or-none learning of the rule, the nature of reinforcement by confirmation, all support the theory advanced in this dissertation. Even if Verplanck's findings are considered as tentative, these studies demonstrate the accessibility of verbal rules for studying the higher mental processes.

Summary

A theory of verbal coding systems as the basis of higher mental processes was developed from the theories of Osgood, Bruner, and Luria; it has been the purpose of this part of the review to examine other lines of evidence to check the adequacy and to extend the theory. The following tentative conclusions could be drawn:

1. Plans as described by Miller, Galanter, and Pribram are comparable to "rules" as employed in this dissertation. Metaplans correspond to rules about the formation of rules. The virtue of the conception of rules is that they are presumably more directly accessible by way of speech than are Plans.

2. Mowrer, Goldstein and Scheerer, Ausubel, Kendler and Piaget all present theoretical models suggestive of the transition of behavior from the level where stimuli, including words have an impelling function operating according to the feedback principle, to the level, typical of humans, in which behavior is regulated by the meaning, significative or representational aspects of speech.

3. Concept attainment can be conceived as a problem solving situation in which the subject must find, articulate, and operate according to an appropriate verbal rule. General concepts correspond to general verbal rules. Related verbal concepts are called verbal coding systems.

4. Much of the research in concept attainment has not been too fruitful because of the unjustified assumption that human subjects do not operate according to verbal rules unless these are provided in the design. Rather, all adult human subjects form rules, or operate on the basis of the symbolic aspects of speech. Thus speech, it has been argued here, constitutes the central problem in cognition; it is not simply another variable to be considered in interpreting experimental results.

5. The effects of verbal labeling in children are quite clear. Presenting verbal labels permits the child to operate at the higher, cognitive level in terms of general concepts rather than simply conditioning to stimuli

which act according to the feedback principle.

6. The effects of verbal labeling in human adults is harder to specify. Since all adults act on the basis of verbal mediation, labeling in adults serves a different function than in children.

7. The validity of many of the labeling experiments with adults can be questioned on the grounds that the labeling simply provides the subject with information as to the intentions and desires of the experimenter. Labeling overtly may be redundant if this information is transmitted by instructions which activate the appropriate covert speech; otherwise it appears to have some facilitatory effect.

8. Unstructured overt verbalization appears to facilitate the solving of complex problems. Overt and covert speech become necessary in the solving of very complex problems. It is suggested here that permitting overt verbalizations is unnecessary in simpler tasks. Moreover, verbalizing may have some effect on subsequent performance due to its attentional and practice values.

9. The <u>content</u> of the verbalizations, the verbal rules, are accessible and central to the study of the cognitive functions in problem solving, concept attainment, and classroom learning.

CHAPTER III

DEFINITIONS, POSTULATES, AND HYPOTHESES

Definitions

Verbal - a symbolic representation within the logical structure of the language. In this dissertation, it is used in a generic sense to include both preverbal and subverbal speech and other types of symbolic representation.

Symbolic - the process of representing an object or event by a sign or signal. This sign or signal produces a response different from that which could be expected on the basis of the physical characteristics of the sign itself.

Cognitive - the higher mental processes including problem solving, concept attainment and thinking in general. In this dissertation, cognition is conceived as being dependent on the symbolic processes, particularly language.

Concept - a verbal rule for classifying sensory information. With repeated use these rules come to be replaced by a single word which is more generally referred to as a concept.

Verbal rule - a conscious, cognitive process based on speech. The rule is similar to an hypothesis. In this thesis,

it is conceived as central to the control of all voluntary behavior.

Concept attainment - the formation and verification of a verbal rule which may be used for classifying a limited amount of stimulus information.

Overt verbalization - verbal self-instructions occurring at an audible level. In this study, the overt verbalizations were elicited as responses to loosely structered questions.

Covert or implicit verbalization - the speech assumed to be operative in the regulation of behavior but inaudible to an observer. Presumably, there is a progression in the role of verbalization from overt speech to covert speech with the gradual disappearance of the more gross muscular movements.

Semantic - the stimulus function of a word which pertains to the symbolic aspect or meaning of the word as opposed to the physical properties of the word.

Perceptual - responding to the physical properties of the stimulus situation.

Rule-seeking - the tendency to formulate a wide variety of novel verbal rules which may be used to classify information. This class of responses may be referred to as divergent thinking.

<u>Rule-following</u> - the tendency to operate within a single well-established verbal coding system. This type of response may be referred to as convergent thinking.

Postulates

This dissertation takes as its basic postulate that speech, in the form of overt or covert verbal rules, forms the basis of higher mental processes of problem solving, concept attainment and thinking in general. This postulate is derived largely from Luria (1961) who states:

> Whereas temporary links evolve gradually in animals . . . the great majority of temporary links established in man are incorporated at once into an existing category and regulated thereafter by a verbally formulated rule. (p. 22)

Two corollaries of this postulate are relevant to this dissertation:

1. Internalized speech may become activated during difficult problems and may pass back into externalized speech in the event of very grave difficulties.

2. Since the behavior of adult humans is based on verbal rules, the formation and modification of these rules are also based on higher order verbal rules.

Derivation of Hypotheses

I. Since orienting to very difficult situations may depend on overt speech, overt verbalization may facilitate

the solving of these complex problems. Moreover, verbalizing during the task may help to articulate the verbal rules that constitute the solution to the problem. These deductions give rise to two testable hypotheses:

I - 1. Children required to verbalize overtly during the solution of a series of complex problems perform at a higher level than children not required to overtly verbalize.

I - 2. Children provided with instructions to articulate covertly the verbal rules necessary for problem solution perform at a higher level than children not given these instructions.

II. Although the rules which have been most frequently discussed in the presentation of theory refer to somewhat specific reactions to specific situations, it is assumed that higher level rules regulate the formation of these more specific rules. Whereas the more specific rules operating at a lower level are usually consciously taught and subject to almost immediate confirmation, the latter are probably formed early in life, pick up uncontrolled reinforcements and stabilize without ever being carefully articulated. These higher level rules are similar to the Metaplans proposed by Miller, Galanter, and Pribram.

The particular higher level rules of interest to this study are the ones having to do with the production of other

verbal rules. Training subjects to generate or seek numerous verbal rules should have a beneficial effect on cognitive tasks. New problems require the subject to produce a new rule to use in that situation. Hence, children capable of producing new rules should be able to construct the needed rule more easily than less "rule-fluent" children. The effect should be strongest in situations requiring the uncritical production of numerous rules such as is required in creativity or divergent thinking tests. These deductions give rise to two major testable hypotheses:

II - 1. Reinforcing rule-seeking behavior in children will have a facilitating effect on the solution of subsequent cognitive problems. The effect will be most pronounced on unstructured, creativity tests and least pronounced on the highly structured, problem solving tests.

II - 2. Reinforceing rule-following will lead to the inhibition of rule-seeking; it will have a detrimental effect on the solution of subsequent cognitive problems.

CHAPTER IV

EXPERIMENTAL DESIGN

The general thesis as to the role of verbal rules in higher mental processes was examined in two independent experiments. The experiments are similar only in that in both of these studies the independent variable is the formation of verbal rules. The first study attempted to involve the verbal rules directly by requiring the subjects to verbalize overtly as they solved a series of complex abstract problems.

The second study, although carried out to examine the same general thesis, was designed in such a way that the independent variable, rule-formation, was introduced through a series of training sessions. The criterion or post-tests were administered under identical conditions to both the trained and control groups. This second design was superior in that differences on the post-test could be attributed with more certainty to the training sessions, not to mechanics of the testing situation. Moreover, the treatment conditions were set up in such a way as to bypass the problem of transfer of training. The training conditions employed materials which had no information which could be transferred directly to the post-tests.

More specifically, the hypotheses advanced were tested as follows:

1. Hypotheses I - 1 and I - 2 were tested by having thirty-six Grade IV and V children divided into three comparable groups, take the Raven's Progressive Matrices under three different conditions: Group I, the Control, was given the publisher's instructions; Group II, the Instructional Set Group, was given special instructions to covertly verbalize the appropriate rule; and Group III, the Verbalizing Group, was required to overtly verbalize the reason for each answer. The testing of these hypotheses are described in Experiment I.

2. Hypotheses II - 1 and II - 2 were tested by comparing the effects of three types of treatment on a series of cognitive tasks. Forty-five Grade V children were randomly assigned to the three treatment groups; Group I, the Control, received no special treatment; Group II, the Rule-Followers, were trained to sort stimulus cards on the basis of some verbal rule; Group IV, the Rule-Seekers were trained to form a variety of verbal rules which could be used to sort the stimulus cards. Effects of the treatments were examined by pre-test to post-test changes. The testing of these hypotheses are described in Experiment II.

CHAPTER V

EXPERIMENT I

Experiment I was designed to examine the role of verbal rules in the cognitive processes by testing the following hypotheses:

I - 1. Children required to verbalize overtly during the solution of a series of complex problems perform at a higher level than children not required to verbalize overtly.

I - 2. Children provided with instructions to articulate covertly a verbal rule necessary for problem solution perform at a higher level than children not given these instructions.

I. EXPERIMENTAL DESIGN

The Sample

The subjects for this experiment were drawn from the Grade IV and V classes at the University Elementary School. Of the students in the combined classes, three were excluded because of a lack of background information such as intelligence quotient and achievement. By the use of random numbers thirty-six of the remaining forty-nine subjects were assigned to one of three experimental treatments.

Following the formation of these three groups the representativeness and comparability of the groups was

examined by comparing the mean ages, intelligence quotient, and achievement, grade level, and sex.

Test Instrument Used

As parallel studies (cf. Gagné and Smith, 1962) have shown an advantageous, incremental effect of verbalizing during the solution of a series of complex problems, it was decided that the task to be used should sample the more basic cognitive skills. That is, verbalization has been shown beneficial especially in situations in which more specific learnings were relevant. In order to go beyond this a test measuring general cognitive ability, largely independent of specific learning, was sought.

Secondly, because of the exploratory nature of the study a standardized problem-solving test which is easily scored and readily interpreted was considered desirable.

Both of these criteria were satisfied by the Raven's Progressive Matrices (1956) a widely used non-verbal intelligence test. The test items are well described as problem-solving tasks. The test consists of sixty items classified into five sets or subtests. The first problem of each set is simple enough to be self-explanatory with successive items becoming increasingly difficult. Each item consists of a matrix of nine geometric figures, one of which is omitted; the answer must be selected from among six or

eight alternatives. Generally, the items demand that the subjects educe the principles operating in the matrix and go beyond to educe the nature of the missing element. The items are not entirely independent, rather each series of twelve items are related to some abstract principle, such as combination, addition, progression, and rotation of symbols.

As a standardized intelligence test, several writers including Raven (1956) and Vernon (1950) have reported the factor analytic composition of the test as consisting almost exclusively of a general intellectual ability factor with a "g" loading of over .79. The test has a reported re-test reliability of .88.

The test was selected for use in this experiment because of its dependence on general cognitive skills, its dependence on verbalizable principles, and its standardized, highly reliable scores.

The Experimental Groups

As was pointed out above, twelve subjects were randomly assigned to each of three experimental groups. The control group, Group I, was given the Raven's in the standard way, Group II was given special instructions to covertly formulate a verbal rule for each task, Group III was required to overtly verbalize a reason for each response during problem solution.

Subjects in all three groups were tested individually with the experimenter recording the answers for all groups including the overt verbalizations of Group III.

The introduction and preliminary trials were identical for all three groups. The differences in treatments were as follows:

Group I - Control Group. Subjects in this group were given the instructions which regularly accompany the Raven's. In addition, prior to the testing, they were permitted to solve the first item in each of the five subtests as an example problem. Subjects unable to solve the example problems were given whatever amount of explanation was necessary by the examiner. This explanation to the Control Group was introduced in an attempt to equate the amount of explanation given the three groups on the practice problems. After these five example problems had been solved, the subject returned to the front of the book and worked through the entire book of problems. After the subject pointed to the answer he selected, the examiner asked, "Are you sure?" Subjects were warned that this question was to be repeated after every item whether they had been right or wrong. This question was introduced in an attempt to equate the groups on the amount of attention given to any one problem. After the child indicated his satisfaction with the answer, he was permitted to go on to the next item. The complete set of

instructions given to subjects in this group are presented in Appendix A.

<u>Group II - Instruction Set Group</u>. The procedure employed by this group was designed to see if establishing a set to look for rules would be as adequate as actually requiring subjects to overtly form a rule for each problem. This group was given the instructions which regularly accompany the Raven's. In addition they were told that the best way to solve these problems is to find the rule that you can use to pick the correct answer. Subjects were advised to say the rule to themselves both before and after they selected an answer. The examiner assisted them in forming the rule for the first practice problem and required the subjects to verbally formulate the rule on the remaining practice problems. When the examiner was satisfied with the accuracy of the rules and answers on each of the practice problems, subjects were permitted to work through the test indicating to the examiner only the correct response, not the rule.

At one point during the test, subjects were reminded to look for the rule and say it to themselves.

After the practice trials were completed, the procedure employed in administering the test to this group was identical to Group I. The complete set of instructions given to subjects in this group are presented in Appendix A.

Group III - Verbalizing Group. The treatment for this group was designed to see if the overt formation of verbal rules during problem solving had a beneficial effect on problem solution. The treatment for the group again consisted of the standardized instructions, a general statement of the best way to solve these problems using the verbal rules, and the five practice problems for which subjects were required to establish the verbal rule that could be used to select the correct answer.

The difference in treatment of this group resided in that each subject was required to overtly state a verbal rule at each step of the solution for each problem. This verbalization was elicited by the experimenter asking the subject if there was any change in the pattern of symbols as you go across the page, and if so, what rule accounted for the change. The question was repeated for changes as you go down the page. After the subject indicated his answer, the experimenter asked, "Why did you pick that answer?" After the child's atatement to each of these questions, regardless of their adequacy, the child was permitted to go on to the next item.

Because of the difficulty of communicating clearly to Grade IV and V children, some latitude was permitted in the experimenter's phrasing of these questions.

The complete set of instructions given to the subjects

and examiners are given in Appendix A.

Data Collection

It was originally proposed that subjects be paced in order to equate the time spent on each problem for subjects in the three groups. Two pilot experiments showed that the test required considerably more time if subjects were required to verbalize during problem solution. However, efforts at pacing the subjects were ineffective. The time required for the solution of each problem was not consistent for all subjects, one child taking longer on some problems and not on others. Moreover, subjects not overtly verbalizing but forced to move slowly, that is, at the rate established by the verbalizers of Group III, often appeared bored. Instead of concentrating for a longer time, once they had solved the problem it had no further interest for most of them.

Because of these problems, efforts at pacing the subjects were discarded and subjects were permitted to operate at their own rate.

In order to compensate for this time difference and to allow for the review provided for Group III by the asking of the question "Why did you pick that answer?" the subjects in Groups I and II were asked the question "Are you sure?"

Six senior education students assisted the experi-

menter in the collection of the data. Subjects were individually tested, four at a time, on each of three successive mornings.

Because of administrative problems, four subjects were not handled on schedule and were examined the following day.

The Data. The data gathered pertaining to the subjects prior to the experiment consisted of:

1. Age
2. Sex
3. Grade level
4. California I.Q. - Grade I
5. Gates Standardized Reading Test - Grade IV
   a. Word Recognition
   b. Paragraph Reading

This data which was obtained from the confidential pupil record files was used to test the comparability of the groups.

The data gathered during the experiment consisted of:

1. Score on each set of items from the Raven's Matrices.
2. Total test score.
3. Time required for completion of the test.

Analysis of the Data

All of the data collected in this experiment were examined by means of parametric statistics if the underlying assumptions regarding normalacy of score distribution and

homogeneity of variance could be met. Because the analysis of variance is considered a "robust" test (Winer, 1962, p. 93) the assumptions were tested leniently, that is, frequency distributions were sujectively examined for normalcy, and homogeneity of variance was tested using Hartley's $F_{maximum}$ statistic (Winer, 1962, p. 93). Heterogeneity of variance was accepted only if the calculated value of the $F_{max.}$ statistic exceeded the expected value at the .99 level. Non-parametric statistics were employed when the assumptions underlying the corresponding parametric statistic could not be granted or when some special relationship within the data was to be shown. The statistical levels for rejection of the null hypothesis were set at the $p < .95$ and $p < .99$.

II. FINDINGS

Preliminary Data Analysis

To test their comparability, the three groups used in the experiment were examined on a number of variables. The mean ages, intelligence quotients, and achievement scores were tested for significant differences among the groups by a series of one-way analysis of variance. (Ferguson, 1959 , p. 227). Hartley's test was used to test the unbiased variance estimates for homogeneity. The grade level and

sex composition of the groups were compared by χ^2 tests of independence. (Ferguson, 1959, p. 165). The statistical descriptions of the groups and the tests for significant differences among groups are presented in Table I.

An examination of Table I shows that the three experimental groups were not significantly different on any of these matching variables prior to the experiment. The three groups are comparable; any differences between the groups at the end of the experiment may be attributed with some confidence to the treatment effects.

Experimental Results

The effects of the two treatment and one control condition on the scores obtained on the Raven's Matrices were analyzed by comparing the subtests and total test scores across the three groups. A two-way analysis of variance with repeated measures (Winer, 1962, p. 298) was used to test for significant differences among treatments, among subtests and among treatments on particular subtests. To meet the limitation of this linear model, that there are no carry-over or transfer effects from subtest to subtest, subtest A was excluded on the assumption that this subtest would absorb any initial learning effects. Moreover, as a majority of subjects solved all twelve problems of subtest A correctly, it was concluded that this subtest was not dis-

TABLE I

SIGNIFICANCE OF THE DIFFERENCES AMONG THE THREE GROUPS FOR SIX RELEVANT VARIABLES PRIOR TO EXPERIMENT I

		Group I Control	Group II	Group III	Obtained F, F_{max}, χ^2	Level of Signif.
	n	12	12	12		
Age	Mean	120.75	122.83	122.33	$F = 0.34$	N.S.
	SD	6.20	5.85	6.91	$F_{max.} = 1.40$	N.S.
Sex	Male	7	5	6	$\chi^2 = 0.67$	N.S.
	Fem.	5	7	6		
Grade	IV	7	7	6	$\chi^2 = 0.67$	N.S.
	V	5	5	6		
IQ	Mean	111.42	112.83	111.58	$F = 0.19$	N.S.
	SD	16.95	19.50	17.62	$F_{max.} = 1.46$	N.S.
Word	Mean	4.36	4.58	4.54	$F = 1.14$	N.S.
Recog.	SD	2.19	2.19	1.92	$F_{max.} = 1.30$	N.S.
Para.	Mean	4.14	4.48	4.02	$F = 0.49$	N.S.
Read.	SD	2.90	3.66	2.92	$F_{max.} = 1.60$	N.S.

criminating among subjects. The subtest means and the total means for the three groups are presented in Table II. An examination of Table II shows that the mean scores for Group III, the verbalizing group, are consistently higher on the subtests and total test. No consistent differences appear between Groups I and II.

The summary of the analysis of variance employed in testing these subtest and total Raven's means for the three treatment groups is reported in Table III.

An examination of Table III shows that there are no statistically significant differences among the three groups on either the subtests or the total Raven's tests. There is no significant interaction between the treatments and the subtests. The differences among the subtests are highly significant although the F value is perhaps somewhat inflated due to the lack of homogeneity of variance. However, this latter finding is of no relevance to this study.

The significance of the difference in mean length of time required by each of the treatment groups in completing the Raven's is presented in Table IV. This table shows that subjects in Group III, the verbalizing group required significantly more time to complete the Raven's than did the subjects in Groups I and II who were not required to give overt verbal reasons for their responses during the solution of the problems.

TABLE II

CELL MEANS FOR THE RAVEN'S SUBTESTS AND TOTAL TEST FOR THREE TREATMENT GROUPS AND THE TOTAL GROUP

Groups	Raven's Subtests B	C	D	E	Raven's Total
I Control	10.41	7.58	8.25	4.66	30.89 SD = 9.68
II Instructions	10.00	8.83	8.33	4.42	31.58 SD = 5.83
III Verbalizers	11.00*	9.33*	8.93*	5.09*	34.35* SD = 6.73
Total Group	10.46	8.58	8.50	4.72	32.27

*Treatment group obtaining highest mean.

TABLE III

SUMMARY OF ANALYSIS OF VARIANCE FOR SUBTEST AND TOTAL RAVEN'S MEANS FOR THREE TREATMENT GROUPS

Source of Variation	SS	df	MS	Obtained F, Fmax.	Level of Signif-icance
Between Subjects	466	35			
A (Treatments)	20	2	10.00	0.74	N.S.
Subjects within groups	446	33	13.51		
Homo. of Variance		3,11		3.19	N.S.
Within subjects	833	108			
B (Subtests)	627	3	209	107.18	$p < .01$
AB	13	6	2.17	1.11	N.S.
B x subjects within groups	193	99	1.95		
Homo. of Variance		3,33		2.47	$p < .05$

TABLE IV

SIGNIFICANCE OF THE DIFFERENCE IN MEAN LENGTH OF TIME (IN MINUTES) REQUIRED TO COMPLETE THE RAVEN'S FOR THREE TREATMENT GROUPS

	Group I Control	Group II Instruc.	Group III Verbaliz.	Obtained F, $F_{max.}$	Level of Significance
Time Mean	36.75	34.50	64.75	F = 34.09	$p < .01$
SD	8.03	6.70	13.78	$F_{max.} = 4.28$	N.S.

III. DISCUSSION

The hypothesis regarding the beneficial effects of overt verbalization on problem solving, received some experimental support. Although the data failed to reach a satisfactory level of significance, the verbalizing group, Group III, scored consistently higher on the Raven's subtests and on the total test.

The small beneficial effects of overt verbalization observed in this experiment cannot be attributed with any certainty to the mediational effect of speech. Since the verbalizing group took significantly more time to solve the problems some advantage may have been derived from the extra time involved. This possibility is somewhat limited for two reasons. First, subjects in groups other than the verbalizing group were asked "Are you sure?" after each answer was given. That is, they had to re-focus on the problem much as the verbalizing group was required to do in explaining the answer. Secondly, the extra time spent on the Raven's was not necessarily an advantage. Fatigue and boredom could be expected after thirty or forty minutes. Moreover, a large part of the extra time required by subjects in the verbalizing group was taken up by the explanations and descriptions of the problems after the solution had been found and in waiting for the examiner to record the verbalizations.

It may be stated, with some equivocation, that the overt verbalizations by the subjects during problem solving, appeared to help define the required cues and to articulate the relationships essential to the solving of the problem.

The effect of the overt verbalization, however, failed to reach an acceptable level of significance. The facilitatory effect of the overt verbalization in this experiment is either non-existent or very small. In either case this finding has some importance. It may be suggested that the control group verbalized covertly as effectively as the treatment group verbalized overtly. As Luria (1961) pointed out and demonstrated by electromyographic studies, internal speech is latent in all thought. In the case of this dissertation, making these processes overt did not change the mode of operations or the quality of the processes. Even with ten to eleven year old children, covert speech appears to be an adequate substitute for overt speech. As Kendler and Kendler's (1962) findings indicate, beyond the age of seven relevant overt verbalizing has little effect on problem solving, presumably because of the adequacy of the covert speech processes.

The lack of a significant difference between the verbalizing group and the control group in this study may, therefore, be attributed to the fact that subjects in a problem solving situation verbalize at a covert level

<u>whether they are required to or not</u>. It is very difficult to suspend verbalization and if one does it becomes extremely difficult for subjects to solve complex problems. (Novikova, 1961) To increase the contrast between the verbalizers and the control it would have been necessary to interfere in some way with the covert verbalizations of the control group. In this study no attempt was made to inhibit or interfere with the covert verbalizations of the groups, hence, control subjects could still have the benefits of speech without being in the verbalizing group.

The lack of significant effects of overtly verbalizing found in this study casts some doubt on the generality of the advantageous effects of overt verbalizations. Gagné and Smith's (1962) finding may be interpreted as an artifact of their research design; perhaps practice or transfer effects over a series of highly similar tasks account for the gain. The beneficial effects of overt verbalization in their study did not occur on the first task; it was only with the presentation of several similar tasks that the effects began to show. It would be interesting to know the effects of overt verbalizing during the solution of the final complex task if overt verbalization had not accompanied the preceding tasks. The theory and findings of this thesis would suggest that overt verbalizing on the most complex

task would have only limited effect; the overt verbalizing group could be made to contrast with the control only by interfering with their inner speech. The findings of Gagné and Smith, therefore, appear to depend on more than the facilitating effect of speech on the thought processes.

Hypothesis I - 2, which suggested that providing an instructional set to look for and covertly verbalize the appropriate rule would produce a beneficial effect on problem solving received no empirical support in this experiment.

This finding is explained on the basis that the nature of the task, a cognitive, problem solving test, forced the subjects to covertly verbalize the rules or principles leading to the solution. Hence, additional instructions of this nature do not cause the subjects to verbalize any more than they would have without the instructions. If, for example, the task had been designed so that the subjects in the control group considered the test an art appreciation test rather than a problem solving test, the instructional set to one of the other groups could be expected to have a greater effect. This point is well documented in a study by Reed (1946) in which the set given to subjects prior to the task produced considerable difference in the concept attainment performance. Subjects told to learn labels, succeeded in finding the concept sixty-seven per cent of the time; subjects told to discover the basis of the group-

ing succeeded eighty-six per cent of the time.

In general, the evidence collected in this study suggests that overt verbalization and providing a set to look for the appropriate rule have only a slight, if any, effect on problem solving behavior. This finding is explained on the basis of implicit speech processes; requiring these speech processes to be overt has only a minimal effect and does not change the approach to the task. Similarly, the instructional set was unnecessary because the verbalizations underlying problem solving are sufficiently well developed to operate covertly and the object of the test is sufficiently clear that special instructions are unnecessary.

Summary

In an attempt to examine the role of verbal rules in the higher mental processes, the Raven's Progressive Matrices was administered to thirty-six Grade IV and V children randomly assigned into three experimental conditions. On the basis of an examination of five matching variables including age, intelligence quotient, sex, grade, and school achievement, the groups were shown to be comparable. To test the hypothesis that overt verbalization facilitates the solution of complex problems, subjects of one group were required to state their reasons for selecting

a particular answer for each problem on the Raven's. To test the hypothesis that providing instructions to covertly verbalize facilitates the solution of complex cognitive problems, a second group was told to state to themselves the appropriate verbal rule before and after selecting the answer. A third group served as a control and was given only the publisher's standard instructions.

The effects of the experimental conditions were examined by an analysis of the Raven's subtest and total test scores across the three groups. The overt verbalizers scored higher on the subtests and the total Raven's although the differences did not approach a satisfactory level of statistical significance. On the basis of these findings it was tentatively concluded that either overt verbalization or providing an instructional set to look for the appropriate rule have only a small, if any, effect on problem solving. The findings may be explained on the basis of implicit speech processes; it is possible that the verbalizations underlying problem solving are sufficiently well developed in these children to operate effectively at a covert level. If so, requiring these speech processes to be overt and encouraging children to use covert speech are unnecessary and redundant; children operate on the basis of verbalizations whether the experimenter requires it or not.

CHAPTER VI

EXPERIMENT II

Experiment II was designed to examine the formation and modification of verbal rules by testing the following hypotheses:

II - 1. Reinforcing and rule-seeking behavior in children will have a facilitating effect on the solution of subsequent cognitive problems. The effect will be most pronounced on unstructured creativity tests and least pronounced on highly structured, problem solving tests.

II - 2. Reinforcing rule-following will lead to the inhibition of rule seeking; it will have a detrimental effect on the solution of subsequent cognitive problems.

I. EXPERIMENTAL DESIGN

The general design of this experiment involved pre-tests, treatments, and post-tests.

The Sample

The subjects for this study were drawn from the two Grade V classes of Garneau Elementary School. Of the fifty-six students enrolled in these classes, two were excluded from the sample because of extremely poor academic records, five others were excluded because of a lack of background

data. By the use of a table of random numbers, forty-five of the remaining forty-nine children were assigned to one of the three experimental groups.

Testing Instruments

In order to assess the effects of the different treatments, a number of tests and instruments were obtained or constructed for this experiment. This battery of tests included the following:

1. Lorge-Thorndike Non-Verbal Intelligence Test Level 4, (1957). Only the second subtest was administered because of the limitation in classroom time. This particular subtest was selected for use as a pre-test because of its obvious similarity to the Raven's Matrices which was to be used as a post-test of problem solving. Elley's (1961) factor analytic results indicated that this subtest of the Lorge-Thorndike is independent of specific verbal and numerical skills and is highly loaded on a general cognitive factor as defined by high loadings on the Raven's Matrices and the Cattell Test of g.

The test items require the subject to select from among five alternatives the design that is similar in principle to the three stimulus designs. As a standardized measure of intelligence, the total test has a reported split-half reliability coefficient of .93 and is regarded as one of the better intelligence tests of today. (Buros, 1958)

2. Raven's Standard Progressive Matrices (1956). This test, selected as an index of a highly cognitive problem solving ability, has been described in Experiment I.

3. Minnesota Tests of Creative Thinking - Non-Verbal Form A and Abbreviated Form VII. Creativity may be described as the ability to exhibit behavior which is new or novel. As such, creativity may be considered as one important aspect of the higher mental processes. Getzels and Jackson (1962) found that creativity scores account for a significant part of the school achievement variance not attributable to intelligence scores. Whereas Intelligence Quotient and Creativity both correlated with achievement in the neighborhood of .5, the correlation between Intelligence Quotient and Creativity was only .10 to .20. Hence, the creativity of an individual is an important and somewhat independent cognitive variable. The creativity tests employed in this thesis were devised by E. P. Torrance and his associates. These tests have been widely used and are described in detail in several studies including Getzel and Jackson (1962) and Torrance (1962).

Creativity is of particular relevance to this study in that creativity may be conceived as the uninhibited formulation of a wide variety of verbal rules. If this is the case, the particular treatments in this thesis may influence the performance of subjects on these tasks. Two

parallel tests were selected for pre-test and post-test purposes.

Non-Verbal Form A. This test consists of three tasks all of which are preceded by the instructions to give as interesting and unusual answers as possible. The first task, Picture Construction, required the subjects to make a picture employing a potato-shaped piece of colored paper in the design. The second task, Figure Completion, required the subjects to add lines to each of the ten stimulus figures to make as interesting drawings as possible. The third task, Lines, involved thirty pairs of parallel lines on each of which the subject was to make an interesting drawing. A time limit of ten minutes was allowed for each task. The scores on the three tasks were combined to yield five measures of creativity; Fluency, Flexibility, Originality of Figures, Originality of Titles, and Elaboration.

Abbreviated Form VII. This test is similar to the one described above except that two of the four tasks are verbal tasks. The first task, Figure Completion, employed different stimuli but was similar in nature to the test described above. The second task, Circles, is similar to the Lines task above . Subjects are required to make many interesting drawings using the circles. The third task,

Product Improvement, required the subjects to think of all the cleverest ways of changing a toy dog (pictured in the test booklet) to make it more fun to play with. The last task, Unusual Uses, required the subjects to think of all the unusual uses for tin cans rather than simply discarding them. A time limit of ten minutes was allowed for each task. The acores for the four tasks were combined to yield four measures of creativity; Fluency, Flexibility, Originality, and Elaboration.

4. Verbal Concept Attainment Test. Since concept attainment is a highly cognitive task that is presumably more directly affected by experimental treatments, a concept attainment test was included in this battery of tests. The concept attainment material and general nature of the tasks were adopted from Underwood and Richardson (1956a). Their tasks involved the identifying and naming of descriptive qualities such as color, shape, or texture which were common to a group of stimulus words. For example, the stimulus words sun, fire, iron, coffee, can all be described by the adjective "hot." They prepared a word list of twenty-four stimulus words (exemplars) from which six concepts were to be formed. The words were randomized and the order varied from trial to trial. Each subject, working individually, was presented with a word and was required to respond with a descriptive adjective during

a four second interval. The subjects were also told that only one response was correct and the whole list required the learning of only six words. The experimenter said "Yes" after correct responses. Each subject received fifteen repetitions of the list. The score for each individual was taken as the total number of correct responses in the fifteen repetitions.

Several changes were made in the concept attainment tasks for use in this study. First, in order to minimize the role of memory and interference between concepts, and to adapt the tasks to a Grade V level, the tasks were modified to involve only two concepts simultaneously rather than the six suggested by Underwood and Richardson.

The second major change was that the tasks were modified for group rather than individual presentation. Since concept formation was to be used for both pre-test and post-test purposes, individual presentation was prohibitively time-consuming. Moreover, if concept attainment tests are to be used as an index of other processes such as school achievement, or for assessing the efficacy of treatments they should be easily administered, scored, and interpreted. For these reasons the test was changed to a group test. This change to a group test was made by first labeling the desired concepts as A and B. Instances of the two concepts were presented in random order. The experimenter

would say a word while writing it on the blackboard and pause ten seconds while the subjects recorded their guess as to which category, A or B, the word belonged. The experimenter would then identify the word as an exemplar of either concept A or B. This information either confirmed or infirmed the subjects categorization. The experimenter would then erase the word and pause an additional ten seconds for the subjects to write down a guess of the word which labeled the concept. No information was fed back as to the adequacy of this latter guess. Six instances of each of the two concepts were randomized to form a list of twelve words. The list was repeated twice. Subjects were presented with twenty-four words, twelve instances of each concept. For two of the concepts, the list was repeated three times.

An illustration will clarify the procedure. The experimenter presented the exemplar"tomato" and asked "A or B?" The children had ten seconds to record their guess "A" or "B." The experimenter then stated "Tomato is in A" and then continued "Why is it in A?" The children had ten additional seconds to write their guess as to why tomato was in group A; they may have guessed red, round, soft, tasty, fruit, and so on. The experimenter said nothing to reinforce their guesses. The next exemplar was fire. The same procedure was followed except

that he experimenter would say "Fire is in B, why?" The third or fourth exemplar "ball" would again go in group A. The children continued to guess verbal labels for the concept until they attained the concept "round" which fits all of the exemplars of concept A, and "hot" which labeled all the words in B. Complete instructions and an answer sheet for the concept attainment test are presented in Appendix B.

Two criterion were originally used in the selection of words to be used in the concepts. Underwood and Richardson's (1956a) associative values for each of the exemplars with the concept was used to control the difficulty level of the concept. Secondly, the familiarity of the words was controlled by using words from the Thorndike and Lorge (1944) word list which had a frequency of at least ten per four million. Neither of these criteria were followed completely because of a lack of exemplars meeting both criteria for the seventeen concepts used in this study.

A total of seven two-concept problems and one three-concept problem were constructed for use in this experiment. The concepts and the word lists employed are listed in Table V.

The concept attainment test was designed to yield three different measures of concept attainment:

1. number of concepts correctly solved,
2. number of instances required before the correct

TABLE V

CONCEPTS AND EXEMPLARS EMPLOYED IN THE VERBAL CONCEPT ATTAINMENT TEST

	Example	I	II	III
1.	flea A	ice A	sun A	elephant A
2.	concrete B	peach B	tomato B	bed B
3.	babies A	honey B	blood B	pillow B
4.	rock B	snow A	steam A	city A
5.	diamond B	chocolate B	apple B	wool B
6.	pin A	icicle A	stove A	ocean A
7.		refrigerator A	fire A	mansion A
8.		candy B	brick B	fur B
9.		frost A	coffee A	whale A
10.		sugar B	rose B	skin B
11.			oven A	giant A
12.			cherry B	kleenex B
	A-small B-hard	A-cold B-sweet	A-hot B-red	A-big B-soft

	IV	V	VI	VII	VIII
1.	school A	rod A	cheese A	gasoline A	snow A
2.	shirt B	closet B	moon A	brick B	mouse B
3.	store A	cave B	needle B	boulder B	moon C
4.	house A	earth-worm A	icicle B	goat A	pill C
5.	skirt B	night B	lemon A	armour B	ivory A
6.	tie B	rattle-snake A	harpoon B	hospital A	collar A
7.	theatre A	spear A	straw A	bone B	puppy B
8.	stocking B	dungeon B	tack B	pig A	pollen B
9.	coat B	tunnel B	peach A	sardine A	bracelet C
10.	barn A	spaghetti A	beak B	helmet B	kitten B
11.	garage A			onion A	frost A
12.	hat B			skull B	eyeball C
13.					cradle B
14.					rice B
15.					bread A
16.					olive C
17.					lard A
18.					grape-fruit C
	A-building B-clothes	A-long B-dark	A-yellow B-sharp	A-smelly B-hard	A-white B-small C-round

concept was named consistently,

3. the number of errors made in learning to categorize the instances correctly.

5. Card Grouping Test. This test was designed to be an open-ended variation of the concept attainment test. Presumably this test should involve one-half of the process of concept attainment that of generating hypothesis; the second aspect of verifying them is not involved in this type of test. It consisted of a group of either four or twelve cards with different words printed on them. The words were printed in large letters on 5" x 8" cards and posted in random order on a bulletin board at the front of the class. The test is essentially a group form of the Wisconsin Card Sorting Test except that words rather than pictures were involved.

The task required the subjects to form all the possible groupings using the words on the cards, with the limitation that at least one-half of the words had to go in each group. Subjects were required to name the group-- and to list the words falling in the grouping. The time limit for each task was ten minutes.

Subjects were given one example problem involving the four words--cat, dog, tiger, and wolf--printed on cards similar to the actual task. The specific instructions are given in Appendix B.

The first problem, Set I, involved the words:

tricycle	car	capgun	ship

Set II contained twelve words:

Brown*	apples	lemon*	Green
Robinson	plums*	peaches	Grey*
Orange*	Jones	Black*	bananas

Starred (*) words were printed in blue; the others were printed in orange.

These problems are capable of yielding at least three types of word groupings, including those based on the meaning or semantic aspects of the words and those based on the stimulus aspects of the words. Examples of Semantic groupings would be "toys" for Set I or "fruit" for Set II. Examples of the second type would be "small words" for Set I and "words starting with a capital letter" for Set II. These latter groups will be referred to as "Perceptual" groupings for the lack of a better word. A third type of grouping, the Spelling or alphabetical groupings involves similarities in spelling of the words such as words with "a" in them or words with "e" in them.

The classifying of the subjects responses into these three types of groupings has some pragmatic justification; response groups generated do fall neatly into one of these three categories. Moreover, these distinctions do have some theoretical validity; semantic responses are presumed

to be more heavily dependent on complex verbal coding systems than non-semantic responses. Finally, these same distinctions are employed by other writers. Cohen (1960) has prepared a clinical Conceptual Sorting Test which is similar in principle to the Card Grouping Test. Cohen employs two major types of categories, semantic and non-semantic. Their definitions are consistent with those employed above. He also gives partial credit to alphabetical responses. Shipstone (1960, p. 37) and Wohlwill (1957) make a distinction between perceptual and conceptual responses similar to that employed here.

Background Data and Pre-Testing

In order to attribute any differences between the groups on the post-tests to the treatments involved, it was essential that the groups be equated on the relevant variables. For this reason background data regarding the age, sex, intelligence quotient, and achievement were extracted from the pupil record files.

To supplement this information, a battery of three pre-tests was administered to all subjects. This battery included:

1. Minnesota Tests of Creative Thinking--Non-Verbal Form A.

2. Verbal Concept Attainment Test-Concepts I - V.

3. Lorge-Thorndike Non-Verbal Intelligence Test, Level 4, Subtest 2.

Treatment Groups

It was indicated above that subjects were assigned randomly to one of three treatment groups. Subjects in the first group served as a control; subjects in the other two groups were trained according to the procedure described below.

The thirty subjects in Groups II and III were taken individually to a private room and given fifteen minutes training on three card-sorting tasks each day for five consecutive school days. Two senior education students served as assistants for the training sessions.

Both groups were given the identical training materials, the difference in the training depended primarily on the use made of these materials.

The training tasks were essentially card sorting problems. These tasks as employed in other studies (cf. Grant and Curran, 1953) generally involve a stack of cards varying in a limited number of dimensions which must be sorted into two or four piles on the basis of some predetermined attribute. From the subject's point of view the task may be considered as one of finding the rule for card-sorting upon which the experimenter has previously decided. The experimenter reinforces the placement of the card in the correct pile by saying "Yes." The task continues until

the subject can sort the cards without error.

The stimulus cards used in the training sessions of the present experiment were children's "trading" cards. Approximately six hundred trading cards drawn from such series as Zorro, Baseball, Football, Hockey, and American Civil War pictures, formed the pool from which the ten sets used for training were chosen. These cards were considered suitable because they eliminated the possibility of direct transfer of training effects. Moreover, as the cards differed in an unlimited number of ways, a virtually inexhaustible number of rules or concepts could be used as the basis of sorting behavior. A typical rule might be, "Cards with athletes go in A," or "Cards with borders go in B." The ten sets of cards were formed from the trading cards in such a way as to minimize the similarity of the rules that could be used for sorting from task to task. For example, the rule "Brown borders go in A" was possible in only one task. Two of these ten sets, chosen at random, were used as a basis of training each day.

The third set of card sorting training tasks used each day was similar to those described above except that words rather than pictures were on the stimulus cards. The twelve cards in each set had four concepts running through them such as cars, words with an "ane" sound, or two words on a card. Table VI presents the words in each

TABLE VI

VERBAL CARD-SORTING MATERIALS USED IN THE TRAINING SESSIONS OF TWO EXPERIMENTAL GROUPS

Set 1	Set 2	Set 3	Set 4	Set 5
	BELIEVE	imnopq	Medicine Hat	Train-
	Sting	dort	Ford Falcon	poles
	SOFT	defghi	Red Deer	troubles-
	toothache	lomp	Chevrolet	Plane
	PAIN	opqrst	Edmonton	pains
Practice Session	Swimming	lany	Oldsmobile	Trailer-
	set	lantort	Volkswagen	truck
	BURNING	xyz	Grande Prairie	Stains-
	sore	cdefg	Dodge Dart	Vein-
	FOLLOWING	loogany	Ottawa	tractor
	STANDING		Buick	bus
	hurt		North Battleford	main-

training task in the order which they appeared.

Card sorting the first day was used for familiarization with the procedures and the requirements of the training sessions.

The procedure was the same for all individuals in both groups. Subjects were required to pick up two cards from the top of the pile and on the basis of some characteristic (s) of the cards to sort them into the same or different piles. Social reinforcement accompanying appropriate behavior was provided by the experimenter's saying "Yes."

Group I - Control Group. No special training was given to this group. These subjects simply took the pre-tests and post-tests along with the subjects of the other groups.

Group II - Rule-Following Group. The treatment for this group was designed to test Hypothesis II - 2 which suggests that being reinforced for rule-following should have a detrimental effect on performance on subsequent cognitive tasks. Subjects in this group were required to sort the deck of cards into piles A and B on the basis of some rule which was announced prior to the sorting. The experimenter reinforced correct placement of the cards in pile A or B by saying "Right." If the card was incorrectly placed, the experimenter said "No." Subjects were permitted to make up the first rule to be used as a basis for sorting each of the three sets of cards. If the five minutes allotted for the task had not expired, the

experimenter provided a second rule and the subjects re-sorted the cards following the new rule. When the five minutes expired subjects would change to the second set of cards. The procedure was repeated for three different sets of cards for each day of training. A record was kept of the number of errore made by each subject in sorting each set of cards. The instructions followed by the experimenter in administering this training procedure are recorded in Appendix B.

Group III - Rule-Seeking Group. The treatment for this group was designed to test Hypothesis II - 1 which suggested that being reinforced for forming and modifying a variety of verbal rules would have a beneficial effect on subsequent cognitive tasks. The tasks and the basic technique employed by this group were identical to those used by Group II. The difference between the treatments resided in the aspect of behavior upon which reinforcement was contingent. Group III was reinforced for generating or forming new rules which could be used as a basis for card sorting. Subjects picked up two cards as did those in Group II but instead of being reinforced for placing them in pile A or B in line with some rule, reinforcement was contingent upon their making up and verbalizing some rule which could be used for sorting.

The rules suggested by subjects were similar in nature to those used in Group II. However, subjects in Group III were requested to give three different rules before they picked up the next pair of cards. If subjects could not think of a new rule, the experimenter suggested one to him. This procedure continued until the allotted five minutes had elapsed and then the subject went on to the next training task. A record was kept of the rules produced by each subject on each task for each day of training. Specific instructions followed by the experimenter in conducting these tasks are recorded in Appendix B.

Post-Tests

The day following the cessation of the treatment sessions was used for administering a series of tests to assess the effect of treatments. This battery included:

1. Raven's Standard Progressive Matrices.
2. Verbal Concept Attainment Test - Concepts VI - VIII.
3. Minnesota Tests of Creative Thinking - Abbreviated Form VII.

These tests were all given in the classroom in one morning from 9:00 - 12:00 a.m. A graduate student served as assistant during the administration of both pre-tests and post-tests.

Analysis of the Data

Since most of the data collected during this experiment were used to compare the differences among the three treatment groups, the analysis consisted primarily of a series of one-way analysis of variance or their non-parametric counterparts. The testing of the assumptions underlying this statistical test have been described in Experiment I. (p. 79)

Pre-test and post-test data were generally examined in the same way. Since the treatment effect of Group II and Group III were directly related to Hypotheses II - 2 and II - 1, respectively, the post-test scores of these groups were compared with those of the Control group following each analysis of variance. If the differences approached significance they were analyzed by statistically comparing the treatment groups individually with the control by means of Dunnett's statistic. (Winer, 1962, p. 89) Levels of significance were set at .05 and .01; a one tailed test was used if the statistic was directly related to a theoretical hypothesis.

II. EXPERIMENTAL FINDINGS

Preliminary Findings

Verbal Concept Attainment Tests. The concept attainment tasks were essentially similar to those designed by

Underwood and Richardson (1956). The major modifications of their test for use in this experiment involved the reduction in the number of concepts attained simultaneously from six to two and the adaptation of the test for group use.

The difficulty level of the tasks employed in this study was consistently overestimated. Whereas the subjects in Underwood and Richardson's studies with verbal concepts produced gradual learning curves over two hundred to three hundred trials, subjects in this study tended to name the concept within the presentation of the first three or four exemplars. When the level of difficulty of the tasks was increased, Underwood and Richardson found that the number of trials to criterion increased as a linear function. In this study increasing the level of difficulty did not generally cause an increase in the number of trials to criterion. Concepts tended to be solved in the first three or four presentations or else not at all. That is, increasing the difficulty of the concepts caused an increase in the percentage of children failing them, it did not cause a marked increase in the number of trials it took an individual to attain them. Repeating the list a second and third time, that is, up to thirty-six trials had very little effect on the attainment of the concept, contrary to the findings of Underwood and Richardson who often re-

peated their lists fifteen times.

Several factors likely contributed to the unexpected functioning of the concept attainment test. First, the difficulty level of the concepts employed was based on the performance in several, small sample pilot runs. Subjects involved in these pilot runs generally had some difficulty attaining the concepts. Because of the limitation in the amount of time a child can be excused from the classroom for pilot runs, subjects were given one or two concepts in a session. The next set of concepts was tested with new subjects. When in the actual experiment, subjects were given four consecutive concept attainment tasks, they appeared to develop a "set" toward the type of responses expected. Once this "set" was acquired, the concepts were more easily solved.

The other major factor responsible for the functioning of these tests is perhaps attributable to the model underlying the Underwood and Richardson tasks. The tasks themselves as designed by Underwood and Richardson are very simple (for example, chalk, milk, snow, and moon are all white). At the most, two or three exemplars are sufficient to delimit the appropriate concept. Underwood and Richardson, however, complicated the problem with memory and interference factors by requiring the subjects to attain four to six concepts simultaneously and by

presenting the exemplars in short, four second intervals. When these complicating factors are minimized the actual concept attainment is relatively simple if it is possible at all. The limitation in this approach perhaps resides in the fact that the verbal exemplars employed are capable of yielding too few hypotheses within the limits of sensory descriptive characteristics imposed by Underwood and Richardson. For example, the exemplar "moon" could give rise to the hypotheses round, white, yellow, or cool. However, when the second exemplar "tire" is presented, only one possible hypothesis, round, remains.

Because these limitations in the Underwood and Richardson approach to concept attainment had not been raised (to the knowledge of the author) the tasks employed in this experiment were not as effective as had been anticipated. Attempts at using the number of trials to criterion as an index of performance were discarded and concepts were simply treated primarily as pass or fail. The score for each individual was regarded as the number of concepts solved correctly.

Card Grouping Test. This task was designed to ascertain the effects of reinforcing rule-seeking and rule-following on the number and nature of the rules formed for grouping the cards. The test is promising in that it is easily administered and easily scored. It has considerable

construct validity in that it tests directly the skill for which it was designed, the ability to formulate verbal rules which may be used as a basis for grouping words. The test also has considerable overlap with concept formation tasks of the card sorting type. (Grant and Curran, 1953). The major limitation of the test is the fact that it is unstandardized. Hence, it is suitable only for experimental purposes and not for determining cognitive parameters.

The administration of the two test items was preceded by an example problem. This procedure is regarded as questionable in that it provided too much direction to the subjects as to the desired types of response. An example of this is the high rate of responses classed as "spelling responses" after one of these had been included in the example problem, as opposed to the low frequency of these responses obtained in the pilot runs. The one example may have provided enough information to the groups to nullify the effects of the training sessions.

A second observation on the Card Grouping Test was that the four card problem was more conducive to Semantic grouping than was the twelve card problem. The large number of cards delineated the concepts so clearly that there was little room for advancing novel groupings. Cohen (1960) uses eight card problems; this is perhaps the best.

number. Cohen's approach is limited, from the point of view of this thesis, in that only well-defined groupings are recognized. Groupings which are only tangentially related to the stimulus cards were not accepted. Cohen's task resembles a convergent concept attainment task whereas those employed in this study are more divergent in nature.

Preliminary Data Analysis

The three groups used in the experiment were examined prior to the treatments to ascertain their comparability. This preliminary analysis was based on background data obtained from the pupil record files and from a battery of pre-tests.

Background Data. The mean ages, intelligence quotients, and achievement scores were tested for significant differences among the groups by a series of one-way analysis of variance. The unbiased variance estimates were tested for homogeneity by Hartley's test. The sex and classroom composition of the groups were compared by χ^2 tests of independence. The statistical descriptions of the groups and the significance of the differences among groups are presented in Table VII. An examination of this table shows that the three groups were not significantly different on any of the six relevant background variables prior to the experiment. On the basis of this analysis the groups were

TABLE VII

SIGNIFICANCE OF THE DIFFERENCES AMONG THE THREE GROUPS FOR SIX RELEVANT BACKGROUND VARIABLES PRIOR TO EXPERIMENT II

	Group I Control	Group II	Group III	Obtained $F, F_{max.}, \chi^2$	Level of Significance
n	15	15	15		
Age Mean	127.13	126.60	126.33	$F = 0.18$	N.S.
SD	4.68	5.21	5.35	$F_{max.} = 1.31$	N.S.
Sex Mean	6	7	8	$\chi^2 = 0.54$	N.S.
Fem.	9	8	7		
Class C	9	8	10		
Z	6	7	5	$\chi^2 = 0.56$	N.S.
IQ Mean	119.07	117.07	121.20	$F = 0.48$	N.S.
SD	10.33	11.55	12.76	$F_{max.} = 1.52$	N.S.
Read. Mean	5.42	5.34	5.53	$F = 0.27$	N.S.
SD	2.50	2.40	2.17	$F_{max.} = 1.33$	N.S.
Spell. Mean	5.85	5.57	6.07	$F = 0.47$	N.S.
SD	1.55	1.68	1.09	$F_{max.} = 2.00$	N.S.

considered comparable and the random assignment of individuals to the three groups was considered acceptable.

Pre-test Data. To further examine the comparability of the groups particularly on the variables to be examined after the treatments a pre-test battery of three tests was administered to all subjects. The Lorge-Thorndike - Subtest 2, and the Creativity subtests were compared across groups by a series of one-way analysis of variance. Hartley's test was used to test the unbiased variance estimates for homogeneity. The means and significance of differences among the three groups on the Lorge-Thorndike and Creativity tests prior to treatments are presented in Table VIII.

An examination of Table VIII shows that the groups are not significantly different on the Lorge-Thorndike Intelligence Test - Subtest 2. Since this subtest is very similar to the Raven's Matrices the equivalence of the groups on this test will permit one to ascribe with greater confidence any differences appearing in the Raven's on the post-test to the effects of the treatments.

Table VIII also shows that the groups are significantly different on the Fluency and Flexibility subtests of the Creativity Test. This significant difference is due to the superior performance of Group III on these tasks. Since differences in Fluency and Flexibility exist among the groups prior to the treatment, any differences in post-test

TABLE VIII

SIGNIFICANCE OF THE DIFFERENCES AMONG THE THREE GROUPS FOR SIX COGNITIVE PRE-TEST VARIABLES

	Group I Control	Group II	Group III	Obtained F, $F_{max.}$	Level of Significance
n	15	15	15		
Lorge-Thorndike Intelligence					
Mean	13.47	11.60	12.27	$F = 1.25$	N.S.
SD	2.62	3.02	3.90	$F_{max.} = 2.22$	N.S.
Creativity Tests					
Fluency Mean	15.60	14.13	19.00	$F = 5.45$	$p<.01$
SD	4.63	4.19	3.48	$F_{max.} = 1.77$	N.S.
Flex. Mean	12.00	11.87	15.06	$F = 3.98$	$p<.05$
SD	3.93	3.25	3.30	$F_{max.} = 1.46$	N.S.
Orig. Mean	20.40	19.47	24.73	$F = 1.71$	N.S.
Design SD	10.70	7.44	6.12	$F_{max.} = 3.04$	N.S.
Orig. Mean	3.13	4.80	3.93	$F = 1.85$	N.S.
Titles SD	2.17	2.14	2.79	$F_{max.} = 1.70$	N.S.
Elabor. Mean	37.33	38.93	42.33	$F = 1.06$	N.S.
SD	11.35	7.71	9.50	$F_{max.} = 2.17$	N.S.

scores cannot be attributed to the treatments. To overcome this problem, gain scores from pre-test to post-test were employed on all of the Creativity subtests in the assessment of the treatment effects.

The third pre-test was the Verbal Concept Attainment Test. The ten concepts presented were scored either pass or fail. These data were examined in two ways. First, the number of problems solved correctly per subject was compared across groups. Since the data did not appropriate the normal form but were highly negatively skewed, a non-parametric equivalent of the analysis of variance, the median sign test for k independent samples was employed. (Ferguson, 1957, p. 267). This test yielded:

$$\chi^2 = 0.19, \text{ with df} = 2, \text{ N.S.}$$

There was no significant difference among the three groups on the Verbal Concept pre-test when the number of problems solved correctly was used as the criterion.

Secondly, the Concept Attainment pre-test scores were examined by a two-way analysis of variance to compare the number of individuals passing in each group, by concepts. The basic model for this test is Friedman's analysis of variance based on ranks. Since the object of the test was to find if the groups differed in the number of individuals passing and not if the concepts vary significantly in difficulty, the classification was reversed. Johnson and

Jackson (1959) state:

> The same procedure as above is used to test the hypothesis that the row classification has no effect on the variable X, except that now the columns are ranked instead of the rows and n and k are interchanged in the formula for χ_r^2 (p. 272).

This analysis is presented in Table IX. This table shows that the number of individuals passing each concept was not significantly different across the three groups. Although the difference did not approach significance, Group III had more individuals passing on the ten pre-test concepts.

Summary. An examination of background and pre-test data showed that the three experimental groups were not significantly different in age, sex, classroom, intelligence quotient, achievement and Lorge-Thorndike - Subtest 2, and Verbal Concept Attainment. The groups were considered comparable on all of these variables; hence, differences occurring in these variables on the post-tests could be attributed to the effects of the treatment and not to the original inequality of the groups. The pre-test data also showed that the groups were significantly different in the Fluency and Flexibility Scales of the Creativity Test. Since any post-test differences among the groups on Creativity could be attributed to the original inequality of the groups, gain scores were employed to remove pre-treatment differences.

TABLE IX

SIGNIFICANCE OF THE DIFFERENCES AMONG THREE EXPERIMENTAL GROUPS RANKED ACCORDING TO THE NUMBER OF CORRECT SOLUTIONS ON EACH CONCEPT IN THE PRE-TEST

Concept	Group Rank Group I	Group II	Group III
1	1.5	1.5	3.0
2	2.5	2.5	1.0
3	2.5	2.5	1.0
4	2.5	1.0	2.5
5	3.0	1.5	1.5
6	2.0	2.0	2.0
7	3.0	2.0	1.0
8	3.0	2.0	1.0
9	1.0	2.5	2.5
10	1.0	2.0	3.0
ΣR_i	22.0	19.5	18.5

$\chi^2 = 0.65$, with df = 2, N.S.

Treatment Data

The data presented in this section were collected during the week of training sessions. During the week each subject received one orientation session and four training sessions. During the course of the week four different subjects missed one training session; on the following day these subjects were given two training sessions. Hence, all subjects in Group II and Group III received five fifteen minute treatments.

The number of errors made by Group II subjects receiving training in rule-following, that is, in sorting the cards according to a verbalized rule, was very small. If an error occurred after the rule for sorting had been given, the subjects frequently commented, "Oh yes" or "Oh I didn't think you meant to include those too." Regardless of the complexity of the rule given to the subjects as a basis for card sorting, errors were very infrequent.

To obtain an estimate of the progress being made during the training sessions by Group III, the Rule-Seekers, records were kept of the number of different rules formed by each subject on each of the five minute tasks. Since the training sets varied in difficulty it is impossible to calculate precisely the increase due to previous training. However, since the tasks were presented in random order,

and since three independent tasks were presented each day, the number of rules generated by each subject on each day of training provides a crude index of improvement in rule-forming ability. Since the first day of training was employed for general orientation, no score was obtained for that day. Figure 1 shows the mean number of rules produced per task for three tasks on each day of training. This figure shows that the subjects were becoming more efficient at generating rules that could be used as a basis for card sorting. Since all of the training cards were somewhat similar in nature this improvement may have been specific to the training tasks. The effects of the treatment on other cognitive tasks was examined in the post-tests.

Experimental Results

A battery of post-tests was administered to all members of all three groups the day following the cessation of treatments. These tests, including the Raven's Progressive Matrices, Verbal Concept Attainment Test, Card Grouping Test, and the Minnesota Tests of Creativity, were all group tests administered after the three groups had been recombined.

Raven's Standard Progressive Matrices. This test was employed to yield an estimate of the effects of treatments on problem solving. The results were analyzed by comparing the subtests and total test scores across the three groups.

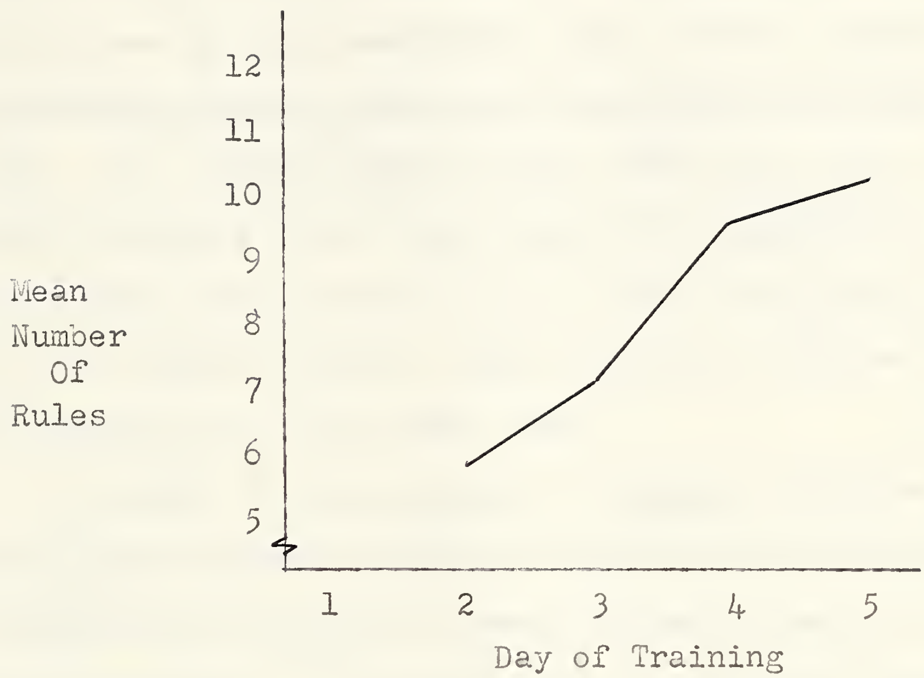

FIGURE 1

MEAN NUMBER OF RULES PRODUCED BY GROUP III OVER THE FIVE DAYS OF TRAINING

A two-way analysis of variance with repeated measures (Winer, 1962, p. 298) was used to test for significant differences among treatments, among subtests, and among treatments on particular subtests. The assumption underlying the use of this statistical test and the reasons for excluding Subtest A have been discussed previously (p. 81). The subtest means and the total test means for the three groups and the total group are presented in Table X. This table shows that the means for Group II tends to be higher than the other groups on three of the four subtests and on the total test.

A summary of the analysis of variance employed in testing these subtests scores and total score on the Raven's for significant differences among treatment groups is reported in Table XI. An examination of this table shows that there are no statistically significant differences among the three treatment groups on the subtests or total Raven's score. There is no significant interaction effect between treatment groups and subtest scores. The differences among the subtests are highly significant although the F value may be somewhat inflated due to a lack of homogeneity of variance.

Verbal Concept Attainment. Two two-concept problems and one three-concept problem were administered following the training sessions to assess the effect of rule-seeking and rule-following training on subsequent concept attainment

TABLE X

POST-TREATMENT CELL MEANS FOR THE RAVEN'S SUBTESTS AND TOTAL TEST FOR THREE TREATMENT GROUPS AND THE TOTAL GROUP

Groups	Raven's Subtests B	C	D	E	Raven's Total
I Control	10.07	8.20	7.87	3.67	29.80 SD=8.24
II Rule-Followers	10.26*	8.20	8.20*	4.67*	31.32* SD=8.03
III Rule-Seekers	10.20	8.80*	7.47	3.80	30.27 SD=6.80
Total Group	10.18	8.40	7.85	4.05	30.46

*Treatment group obtaining highest score.

TABLE XI

SUMMARY OF ANALYSIS OF VARIANCE FOR SUBTEST AND TOTAL RAVEN'S POST-TEST FOR THREE TREATMENT GROUPS

Source of Variation	SS	df	MS	Obtained F, $F_{max.}$	Level of Significance
Between subjects	496	44	3.00		
A (Treatment)	6	2		F = 0.26	N.S.
Subjects within groups	490	42	11.67		
Homo. of Variance		3,14		F_{max} = 1.38	N.S.
Within subjects	1169	135			
B (Subtests)	894	3	298	F = 143.27	p.<.01
AB	13	6	2.12	F = 1.02	N.S.
B x subj. within Groups	262	126	2.08		
Homo. of Variance	3,42			$F_{max.}$ = 4.40	p<.01

The seven concepts involved were marked pass or fail and the resulting data was analyzed in the same way as the Concept Attainment pre-test data. First, the number of problems solved correctly per subject was compared across groups by a one-way analysis of variance. The means and summary of analysis of variance for three treatment groups on the Verbal Concept Attainment post-test are reported in Table XII. This table shows that although the mean for Group III on this measure was larger than for the other groups this difference did not approach a satisfactory level of significance.

Secondly, as in the pre-test, the post-test concept attainment scores were examined by comparing the number of times each concept was solved correctly by each group. This analysis was carried out by an extension of the Friedman two-way analysis of variance. Table XIII presents the significance of the differences among the three groups ranked according to the number of correct solutions on each concept in the post-test. This table shows that significantly more individuals in Group III attained the post-test concepts than the individuals in the other groups.

In summary, both indices of verbal concept attainment showed that Group III, the Rule-Seekers, performed better than either Group II, the Rule-Followers, or Group I, the Control. On one of these indices, the number of indivi-

TABLE XII

MEANS AND SIGNIFICANCE OF THE DIFFERENCES AMONG THREE TREATMENT GROUPS OF THE NUMBER OF CONCEPTS ATTAINED ON THE POST-TEST

	Group I Control	Group II Rule-Followers	Group III Rule-Seek.	Obtained F, $F_{max.}$	Level of Significance
n	15	15	15		
Mean	4.87	4.60	5.13	$F = 0.54$	N.S.
SD	1.84	1.56	1.65	$F_{max.} = 1.40$	N.S.

TABLE XIII

SIGNIFICANCE OF THE DIFFERENCES AMONG THREE TREATMENT GROUPS RANKED ACCORDING TO THE NUMBER OF CORRECT SOLUTIONS ON EACH CONCEPT IN THE POST-TEST

Concept	Group Rank		
	Group I Control	Group II Rule-Followers	Group III Rule-Seekers
1	1.5	3.0	1.5
2	2.5	2.5	1.0
3	2.5	2.5	1.0
4	2.0	3.0	1.0
5	3.0	2.0	1.0
6	2.5	2.5	1.0
7	1.0	2.0	3.0
ΣR_i	15.0	17.5	9.5

$\chi^2 = 4.80$, with df = 2, $p<.05$

duals passing, by concept, in each group revealed a significantly better performances by Group III.

Card Grouping Test. To further assess the effects of the training sessions, one four-card and one twelve-card, Card Grouping problems were administered to the combined groups. The results of this test were analyzed in two different ways. First, the total number of groupings formed by each subject in each group for each problem and the combined problems was examined by a series of analysis of variance. Table XIV presents the mean number of groupings for each treatment group on Task 1 (four-card problem) and on Task 2 (twelve-card problem) and for the two tasks combined and the significance of the differences among the treatment groups. This table shows that the test as a whole does not discriminate significantly among the treatment groups.

To further examine the types of groupings produced by subjects in the different treatment groups, the number of Semantic, Perceptual, and Spelling groupings for the two tasks combined were analyzed by a series of one-way analysis of variance. The results of these analyses are presented in Table XV. This table shows that there are significant differences among the groups on both Semantic groupings and Perceptual groupings. The Control, Group I, was superior on the Semantic groupings, whereas the Rule-Seekers were

TABLE XIV

SIGNIFICANCE OF THE DIFFERENCES OF MEANS
ON CARD GROUPING TASKS FOR
THREE TREATMENT GROUPS

		Group I Control	Group II Rule-Followers	Group III Rule-Seekers	Observed F, $F_{max.}$	Level of Significance
	n	15	15	15		
Task 1	Mean	6.33	5.13	6.27	F = 1.49	N.S.
	SD	2.22	2.17	2.02	$F_{max.}$ = 1.21	N.S.
Task 2	Mean	6.80	6.46	7.27	F = 0.58	N.S.
	SD	2.55	1.74	1.87	$F_{max.}$ = 2.17	N.S.
Total	Mean	13.13	11.60	13.53	F = 1.41	N.S.
	SD	3.70	3.42	2.81	$F_{max.}$ = 1.74	N.S.

TABLE XV

SIGNIFICANCE OF THE DIFFERENCES AMONG THREE TREATMENTS OF THE TYPES OF GROUPINGS PRODUCED ON THE CARD GROUPING TEST

	Group I Control	Group II Rule-Followers	Group III Rule-Seekers	Obtained F, $F_{max.}$	Level of Significance
n	15	15	15		
Semantic Groups					
Mean	6.73	4.93	5.67	F = 3.78	$p<.05$
SD	2.09	1.58	1.75	$F_{max.}$ = 1.74	N.S.
Perceptual Groups					
Mean	2.00	2.80	4.53	F = 5.41	$p<.01$
SD	1.89	1.48	2.87	$F_{max.}$ = 3.80	$p<.05$
Spelling Groups					
Mean	4.40	3.87	3.33	F = 0.54	N.S.
SD	3.27	3.27	1.56	$F_{max.}$ = 4.40	$p<.05$

superior on the Perceptual groupings. The F ratios may have been inflated slightly because of the lack of homogeneity of variance on the Perceptual and Spelling groupings.

The differences among treatments groups were examined more closely by Dunnett's statistic for comparisons of treatment groups with the control group. These comparisons are recorded in Table XVI. This table shows that the Control group scored significantly higher than Group II, the Rule-Followers, but not significantly higher than Group III on the Semantic groupings. Group III, the Rule-Seekers, was significantly higher than either of the other groups on the Perceptual groupings.

In summary, although Group III, the Rule-Seekers, tended to score higher on the combined Card Grouping problems, their performance was not significantly different from the other groups. When the total scores were broken into their component Semantic, Perceptual, and Spelling groupings, the Control group was found to be significantly higher on Semantic groupings while Group III, the Rule-Seekers, was significantly higher on Perceptual groupings. Spelling groupings failed to yield any significant differences across the groups.

Creativity Tests. Because of the significant differences among the groups prior to the treatments, the effect

TABLE XVI

COMPARISON OF TREATMENT MEANS WITH CONTROL FOLLOWING THE F TEST

	$\bar{\bar{T}}_j-\bar{T}_o$	SE	Dunnett's t	df	Level of Significance
Semantic groupings					
Control vs. II	-1.78	.66	2.70	3, 42	$p<.05$
Control vs. III	-1.06	.66	1.61	3, 42	N.S.
Perceptual groupings					
Control vs. II	0.80	.79	1.01	3, 42	N.S.
Control vs. III	2.53	.79	3.21	3, 42	$p<.01$
II vs. III	1.74	.79	t=2.20	40	$p<.05$
Spelling groupings					
Control vs. II	-0.53	1.06	0.50	3, 42	N.S.
Control vs. III	-1.07	1.06	1.01	3, 42	N.S.

of the treatments on creativity was assessed by using pre-test to post-test difference (D) scores (Edwards, 1960, p. 295-296). On the basis of an examination of the graphical plots of the pre-test (X) against the post-test (Y) scores for each of the three treatment groups, it was assumed that the regression lines for the three samples had the same slope. The results of the analysis of variance of the difference in scores on each creativity subtest for the three treatment groups are presented in Table XVII. An examination of this table shows that there were no significant differences among the treatment groups on the creativity subtests. However, on the Flexibility subtest, the mean for Group III, the Rule Seekers, was considerably higher than that for Group II ($t = 1.02$, N.S.) and that for the Control group ($t = 0.99$, N.S.). Similarly, on the Elaboration subtest, the mean for Group III was considerably higher than that for Group II ($t = 1.34$, N.S).

In summary, the Rule-Seekers, Group III, scored higher than the Rule-Followers, Group II, and somewhat higher than the Control on two of the Creativity subtests although these differences failed to reach the desired level of significance.

TABLE XVII

ANALYSIS OF VARIANCE OF PRE-TEST TO POST-TEST DIFFERENCES (D) ON FOUR CREATIVITY SUBTESTS FOR THREE TREATMENT GROUPS

	Group I Control	Group II Rule-Followers	Group III Rule-Seekers	Obtained F, $F_{max.}$	Level of Significance
n	15	15	15		
Fluency					
Mean	36.67	35.73	35.13	F = 0.06	N.S.
SD	11.05	11.65	15.33	$F_{max.}$ = 1.92	N.S.
Flexibility					
Mean	11.13	11.06	13.20	F = 0.65	N.S.
SD	6.12	5.66	5.52	$F_{max.}$ = 1.23	N.S.
Originality					
Mean	0.87	1.87	1.47	F = 0.05	N.S.
SD	9.50	7.45	8.47	$F_{max.}$ = 1.63	N.S.
Elaboration					
Mean	0.80	-3.80	2.47	F = 0.96	N.S.
SD	10.32	14.41	13.55	$F_{max.}$ = 1.95	N.S.

III. DISCUSSION

The hypotheses regarding the positive effects of reinforcing rule-seeking behavior (II-1) and the negative effects of reinforcing rule-following behavior (II-2) on subsequent cognitive performance received some empirical support in this experiment. The general notion regarding the role of verbal rules in the higher mental processes was, therefore, indirectly supported by the findings.

Although the overall findings of this study were consistent with the hypotheses advanced, the training effects were usually small and often failed to reach a satisfactory level of significance. One major factor responsible for the low magnitude of these effects was the shortness of duration of the treatment sessions. These training sessions continued for fifteen minutes a day for one school week, hence, the effects of these treatments on such basic cognitive skills as problem solving, concept attainment, and creativity could be expected to be small.

The treatment involving the reinforcement of rule-seeking behavior in a series of training sessions had a consistent facilitating influence on tasks which relied to a large extent on the formation of a number of different verbal rules. The effect of this treatment first appeared in the increasing number of rules generated for card-sorting on each successive day of training. The generality of the

treatment effects was assessed by the post-tests. This treatment had a significant facilitating effect on the formation of verbal rules basic to concept attainment and to Perceptual card groupings. This treatment also appeared to have some positive effect on creativity scores although the effect was not significant. No effects of this treatment were observed on the Raven's Matrices.

The reinforcement of rule-following behavior in the training sessions appeared to have an effect opposite to that produced by the rule-seeking treatment. The rule-following group scored consistently lower than either the rule-seeking group or the control on the concept attainment, card grouping, and creativity, the tests on which the rule-seekers tended to excel. The rule-following group, however, scored the highest of the three groups on the Raven's Matrices, the test on which the rule-seeking group did most poorly.

This series of observation suggests that the rule-seeking treatment developed to some extent the ability to formulate verbal rules uncritically. As this skill is more essential in tasks requiring devergent thinking, it tended to facilitate the solution of tasks requiring more flexible or unusual answers. On the other hand, the rule-following training appeared to foster attention to only

the relevant aspects of the problem and to only the "correct" answer. This skill is more closely associated with convergent thinking, the ability to solve problems given adequate, well-defined information. This may account for the somewhat superior performance of this group on the highly structured and more convergent Raven's Matrices and the markedly inferior performance on the more divergent tests.

A second major trend in the findings of this study was that the treatments had a more pronounced effect on the tasks which were somewhat related to the training tasks and less effect on the tasks which may be described as ability tests. The performance on the specific training tasks improved as a function of the number of days of training and the performance on the concept attainment and card grouping post-tests was also markedly influenced by the treatments. On the other hand, the tests heavily dependent on the more basic abilities, the Raven's intelligence test and the creativity tests were less susceptible to the effects of the training. This finding is understandable in the light of the obvious difficulty of modifying the basic abilities.

The results on the Card Grouping Test provide some further evidence on the specificity of the training. The

rule-seeking group performed significantly higher on the Perceptual groupings subtest. The card sorting training sessions involved primarily the formation of rules for sorting the "trading" cards. As these cards were multi-attribute picture cards, they were conducive to perceptual groupings, for example, "Cards with borders go in A." The effects of the treatment were, therefore, most pronounced on the Perceptual groupings of the Card Grouping Test. The superiority of the Control group on the Semantic groupings is attributable to the same factor. Trained subjects appeared to develop a "set" to the more perceptual groupings and hence overlooked the Semantic groupings.

The third observation arising from this experiment is the general effect of reinforcement employed in the two treatment groups. In both the rule-seeking group and especially in the rule-following group, reinforcement appeared to put some restraint on the nature of the produced responses. Social reinforcement may interfere with the flexible production of verbal rules in that it tends to restrict the behavior to that which has been reinforced. If this is the case, the best way to encourage creative behavior may be to teach children to be somewhat independent of social reinforcers.

Finally, some support is given to the general

hypothesis that verbal rules as employed in this thesis are basic to the cognitive processes in that even the brief training sessions had some effect on cognitive performance . Furthermore, the verbal rules are subject to study and amenable to psychological experimentation and educational practice.

In general, the experimental treatments employed in this study tended to have the predicted effects. Reinforcing rule-seeking in a series of training sessions appeared to facilitate the production of verbal rules in a number of cognitive tasks, particularly those of a somewhat unstructured type. Reinforcing rule-following behavior appeared to interfere somewhat with the production of verbal rules in these cognitive tasks but it may have facilitated somewhat the verification of the verbal rules a process of some importance in the Raven's.

<u>Summary</u>

This experiment was based on the assumption that children solve cognitive problems by utilizing speech in the form of verbal rules. To examine the role of the formation and modification of verbal rules in the solution of complex problems, forty-five Grade V children were sorted randomly into three experimental treatment groups. On the basis of five background variables including age, sex, intelligence quotient, class, and school achievement the groups were shown to be comparable. The treatments consisted of giving two of the experimental groups practice in sorting multi-attribute children's trading cards into two piles on the basis of some rule. Subjects in the rule-seeking group were reinforced for producing many different rules which could be used as a basis for sorting. For subjects in the rule-following group, reinforcement was contingent upon the adherence to some previously announced rule. The third group served as a control and received no special treatment. The effects of the treatments were analyzed by means of a battery of pre-tests and a battery of post-tests, the latter consisting of the Raven's Matrices, Verbal Concept Attainment, Card Grouping Test, and the Minnesota Tests of Creativity.

An analysis of the results of this experiment showed that the reinforcement of rule-seeking had a significant effect on performance on concept attainment and card grouping and a positive though non-significant effect on the creativity scores. The reinforcement of rule-following behavior appeared to have an opposite effect; subjects in this group appeared to be superior on the Raven's and markedly inferior on concept attainment, card grouping and creativity, although these differences were not significant. On the basis of these results it was tentatively concluded tha the reinforcement of rule-seeking has a facilitating effect on the production of verbal rules, a skill of particular relevance to tasks of a divergent nature. The reinforcement of rule-following behavior, on the other hand, tends to interfere with the generation of verbal rules, but appears to have some facilitating effect on tasks of a convergent nature, in this case the Raven's.

CHAPTER VII

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

I. SUMMARY AND CONCLUSIONS

This dissertation presented an attempt to elucidate the role of verbal rules in the higher mental processes of children. On the basis of several theoretical sources particularly Osgood, Bruner, and Luria, it was postulated that speech in the form of verbal rules is the basis of all voluntary behavior. The cognitive processes including problem solving and concept attainment are assumed to be particularly dependent on speech. Although the control of voluntary behavior begins primarily with overt speech and gradually shifts to covert speech, the major role in the regulation of behavior continues to be dependent on the internalized speech system. If particularly grave difficulties arise, the behavior may once again depend on overt speech.

Two major testable hypotheses were deduced from this theoretical framework. First, it was hypothesized that requiring the subjects to verbalize overtly would have a facilitating effect on the solution of complex cognitive problems. Secondly, it was hypothesized that reinforcement of rule-seeking behavior would facilitate the solution of

subsequent cognitive problems. These hypotheses were tested intwo independent experiments.

In the first experiment, the Raven's Progressive Matrices was administered to thirty-six Grade IV and V children randomly assigned to three experimental groups. Subjects in the overtly verbalizing group were required to state a reason for each answer they selected on the Raven's. Subjects in the second group were given instructions to covertly verbalize the appropriate rule for each question. The third group, which served as the control, was given only the test publisher's directions.

Although the overt verbalizers tended to score slightly higher than the other groups on both the subtests and total Raven's, the the difference was not significant. It was concluded that this experiment did not support the hypothesis that requiring overt verbalization or instructing subjects to covertly verbalize has a beneficial effect on problem solving. The findings suggest that the verbalizations underlying problem solving in this experiment are sufficiently well developed to operate effectively at a covert level. If this is the case, requiring these speech processes to be overt or instructing children to utilize covert speech is unnecessary and redundant; these children apparently operate on the basis of speech whether the experimenter requires it or not.

The second hypothesis was tested by analyzing the effects of three types of treatment on the solution of subsequent cognitive problems including problem solving, concept attainment, and creativity tests. Forty-five Grade V children were randomly assigned to one of three experimental groups. The treatments which continued for fifteen minutes per day for one week, consisted of training the subjects to sort multi-attribute children's "Trading" cards into two piles on the basis of some verbal rules. Subjects in one group, the rule-seekers, received social reinforcement for forming and modifying novel verbal rules which could be used as a basis for card sorting; subjects in another group, the rule-followers, received reinforcement for sorting the stimulus cards into the appropriate category on the basis of some announced rule. The third group which served as the control received no special training. The effects of these treatments were analyzed by means of a pre-test, treatment, post-test experimental design.

An analysis of the results showed that the reinforcement of rule-seeking behavior in a series of training sessions had a significant facilitating effect on concept attainment and card grouping and what appeared to be a small positive though non-significant effect on creativity.

The reinforcement of rule-following behavior in the training sessions appeared to have an effect opposite to that produced by the rule-seeking treatment. Subjects in this group scored higher than the other groups on problem solving but markedly inferior on the concept attainment and creativity tests although again these rules failed to reach the desired level of statistical significance.

These findings suggest that reinforcing rule-seeking behavior has a facilitating effect on the production of verbal rules. Hence, tasks of a somewhat divergent or creative nature tend to be positively affected by the treatment. On the other hand, reinforcing rule-following behavior interferes with divergent thinking processes but has some facilitating effect on convergent problem solving situations. This conclusion is consonant with the view expressed by Torrence (1962) who suggests:

> Educators might do well to consider giving parallel treatment to developing thinking abilities (both creative and evaluative) along with the development of memory and conformity to behavioral norms. This would involve, among other things, rewarding creative thinking. (p. 47)

The reinforcement of rule-seeking behavior appears to be one way or rewarding creativity. Rule-seeking is perhaps only one side or aspect of the thinking processes; rule-following or the validation of these verbal rules may be the other side. As Brunk, Collister, Swift and Stayton (1958)

suggest, reasoning proficiency may be conceived in terms of hypothesis rejecting ability. This skill appears to be of greater relevance in convergent thinking situations. In terms of the theory presented in this thesis, the complementary processes of rule seeking and rule following or rule confirmation appear to provide a theoretical basis for a wide range of cognitive processes from divergent to convergent thinking.

In general, the findings from these two studies are consistent with the general theoretical notion that speech in the form of verbal rules forms the basis of the higher mental processes. The role of speech via covert verbalizations appears to be so extensive that it becomes impossible to design an experiment which can by-pass these verbalizations. Once these processes are well established they operate at a covert level; requiring them to be overt apparently has little facilitating effect.

The importance of the role of speech as emphasized in this study is compatible with the findings in several other areas of investigation. Factor analysts find, somewhat to their dismay, that "intelligence" measures are highly loaded with verbal ability which presumably is learned. However, the theory employed in this thesis would suggest that without verbalization and the develop-

ment of the speech processes, true conceptual intelligence would not emerge.

In the somewhat more "applied" area of science education, Hukins (1963) found that the first two principle factors that were obtained from a factor analysis of science test scores had to be interpreted as verbal factors. As has been maintained in this dissertation, the conception of verbal rules are basic to the higher mental processes. Science achievement would, to a large extent, be dependent on the adequacy of the verbal coding systems pertaining to science. These studies provide some evidence of the relevance and applicability of a theory of verbal rules in the higher mental processes to some of the significant aspects of children's learning. Moreover, this dissertation has provided some evidence that these verbal rules are accessible for experimental study. Hence, it may be concluded that the type of theoretical approach taken in this dissertation is capable of providing some insight into the higher mental processes particularly as they are relevant to education. As Hebb (1960) has suggested, it is time to leave the trivial elaboration of the basic variables inspired by S-R learning theory models and to go on to the experimental exploration of the thought processes. The theory of verbal rules provides a model for such an exploration.

II. IMPLICATIONS

Implications for Further Research

1. It is necessary to recognize the generality of the occurrence of verbalization in the regulation of behavior. One cannot assume that learning or behavior control in humans can operate without involving the speech system. In designing further experiments on the role of verbalization in learning, one must anticipate that the control group will also operate on the basis of overt or covert speech.

2. It is important to recognize the difficulty of inducing changes in the efficiency of fundamental cognitive skills in a brief period of treatment. The period of treatment employed in this study (one week) was too brief to produce any pronounced changes.

3. It is important to recognize the dependency of the cognitive processes on conscious verbalizable rules. If this is the case, it may be possible to be relatively direct in the teaching of new responses. Whereas educators have often naively assumed that merely telling a subject what to do is sufficient to modify his behavior, psychologists have tended to favor more indirect explanations and techniques. The theory employed in this dissertation would suggest that the important aspect is the

instructions or verbal rules wich a person gives to himself. Any technique, direct or subtle, which influences these rules may have considerable value for modifying behavior. In conditioning, the reinforcement may be considered primarily as a verifier of a rule which has been presented verbally. In psychotherapy, the important issue may not be directive versus non-directive counseling, but rather may be the development of all techniques which are useful for the modification of the verbal rules or cognitions used by the client to regulate his behavior.

Implications for Education

1. This thesis supports the view that speech is extremely important in learning. The important aspect of speech is not, however, in mere recitation or repetition, but rather the generation of verbal rules by the child himself which he may use to regulate his behavior. Information should be presented in such a way as to maximize the role of speech by providing for verbal anticipation and the production of verbal hypotheses by the learners. With the production of hypotheses the learning takes on an active character; the child is no longer a passive recipient of information.

2. Verbal coding systems constitute the basis of knowledge of a subject matter area. It follows that the fundamental "structure" of an area of knowledge consists of the system of verbal rules, principles, or concepts around which the remaining information may be organized.

3. Creativity may be considered as the ability to generate a wide variety of verbal rules for dealing with a quantity of information. As such, this behavior may be subject to the contingencies of social reinforcement. Teachers should encourage novel approaches and good hypotheses as well as the "correct" answers.

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APPENDICES

APPENDIX A

EXPERIMENT I

INSTRUCTIONS GIVEN TO GROUP I PRIOR TO ADMINISTRATION OF RAVEN'S MATRICES

"The reason you have been asked to come here is because I'm doing an experiment to try to find out how Grade IV and V children go about solving problems. Today we're going to do this book full of problems. The gentleman (or lady) with you is not going to interfere with your work. He is simply going to write down the answer you select.

"Open your books to the first page. At the top it says Set A; this page is A1. You see what it is? The upper part is a pattern with a bit missing. Each of these bits below (E points to each in turn) is the right shape to fit the space, but they do not all complete the pattern. Number 1 (E points out to individual child) is quite the wrong pattern. Numbers 2 and 3 are wrong--they fit the space, but they are not the right pattern. What about number 6? It is the right pattern but it does not go all over (E points out to individual child). Put your finger on the one that is quite right. (Es notices if this is done correctly; if necessary they give further instructions.) Yes, number 4 is the right one. Do not turn over yet.

"On every page in your book there is a pattern with a bit missing. You have to decide each time which of the bits below is the right one to complete the pattern above. When you have found the right bit, you put your finger on it and

your examiner will write it down. Each time your examiner will say, 'Are you sure'. They are simple at the beginning and get harder as you go on. There is no catch. Try each question. Do not miss any out. Do not turn back. See how many you can get right. For practice also turn over and do the first one of Sets B, C, D, and E. (Es notice if these are done correctly, and if necessary give further instructions)."

When sufficient time has been allowed for everyone to do the practice problems, the person in charge says, "Turn back to A1 now and do each problem in turn."

(Es are assigned, one to each student. They fill in name and grade on the answer form and tell the children that they are there just to record the answers the child selects.)

EXPERIMENT I

INSTRUCTIONS GIVEN TO GROUP II PRIOR TO ADMINISTRATION OF RAVEN'S MATRICES

(Repeat the instructions given to Group I with the following addition).

"The way to solve these problems is to find the rule that you can use to pick the correct answer. Say this rule over to yourself before you look for the answer, then point to the correct answer, and then say the rule to yourself again to see that the answer is a good one. Each time, after you point to the answer, the examiner will say, 'Are you sure?' This should remind you to say the rule over to yourself again. On question A1, you would do it like this: look for the rule, 'The design has short lines going each way so I need a piece with short lines going each way'. Find the right answer, number 4, point to it, and when the experimenter says, 'Are you sure?', say to yourself again, 'short lines going each way' as a check on your answer.

"Turn over to the next practice problem, B1. What rule do make for this one? (Pause) 'Lines going this way and lines going that way, (E gestures)'. Find the answer, and repeat the rule to yourself to see if it is right. (If a subject has difficulty, the examiner explains the problem further).

"All right now turn over and do the practice problems, C1, D1, and E1. Tell your examiner your rule for these practice problems, the correct answer, and then check the rule again. (Each examiner notices if this is done correctly; if not they give further assistance)."

When sufficient time has been allowed for everyone to do the practice problems, the person in charge says, "Turn back to A1 now and do each problem in turn. From now on say nothing to your examiner, simply point to the correct answer, but remember to say the rule to yourself before and after picking the answer."

After ten minutes the person in charge announces, "Don't forget to say the rule over to yourself both before and after you pick the answer."

EXPERIMENT I

INSTRUCTIONS GIVEN TO GROUP III PRIOR TO ADMINISTRATION OF THE RAVEN'S MATRICES

(Repeat the instructions given to Group I and II with the following modifications).

"On every page in your book there is a pattern with a bit missing. You have to decide each time which of the bits below is the right one.to complete the pattern above. The best way to solve these problems is to find the rule you can use to pick the correct answer. Some questions have only one rule, others have two or more rules. Your examiner is going to ask you what the rule is for finding each answer . In other words, you will have to tell him how you picked the correct answer.

"Let us try the procedure. Look again at A1. 'What rule can you use here?" The rule here would be something like: 'It has short lines going each way'. Then pick the correct answer and point to it.

"To help you explain the rules you are using, your examiner will ask you the following questions. 'Is there any change in the design as you gor across the page?' If so, what rule explains or accounts for this change?' Similarly, 'Is there any change in the design as you go down the page? If so, what rule explains this change?'

'What is the correct answer? Point to it.' 'Why did you pick that answer?' On these first few practice problems your examiner will tell you if you are correct.

"Turn over now and do problems B1, C1, D1, and E1 for practice. Your examiner will ask you these questions for each of the practice problems."

When sufficient time has been allowed for everyone to do the practice problems correctly, the person in charge says, "Turn back to A1 now and do each problem in turn."

EXPERIMENT I

INSTRUCTIONS GIVEN TO THE EXAMINERS PRIOR TO ADMINISTRATION OF THE RAVEN'S MATRICES TO GROUP III

Eache subject in Group III is to be asked these questions for each of the problems presented.

1. "Is there any change in the design (pattern) as you go across the page?" (INDICATE WHERE YOU MEAN WITH A PENCIL).

   -if "Yes", ask: "What rule can you use to explain the the change?" OR "What happens when you go this way?"

   -record answer on the answer sheet.

2. "Is there any change in the design (pattern) as you go across the page?" (INDICATE WHERE YOU MEAN WITH A PENCIL).

   -if "Yes", ask: "What rule can you use to explain the change?" OR "What happens when you go this way?"

   -record answer on the answer sheet.

3. "Which on e is the correct answer?" "Point to it."

4. "Why do you pick that answer?" OR "Why?"

   -record answer on the answer sheet.

Then go on to the next problem.

If question 4 causes the child to change to a different answer, put a diagonal (/) behind the first answer to question 3 and record the new answer after the diagonal.

Do not rush the child.

Do not let the child spend an undue amount of time on any one problem.

Do not tell or hint whether the child is right or wrong. You may say "O.K.". or "Fine", etc., after the child gives an answer.

Record the time at the beginning and the end of the test.

A P P E N D I X   B

EXPERIMENT II

VERBAL CONCEPT FORMATION TEST INSTRUCTIONS

The reason we are is because your teacher and principal have graciously given us permission to use this class in an experiment to try and find out how Grade V boys and girls go about thinking and solving puzzling problems. Today we're going to do some problems with the whole group here, but for the rest of the week we'll be taking you out 2 or 3 at a time to the Committee Room to solve some other problems.

For this problem you will be given some words, one at a time and you must try to find out which ones belong in Group A and which ones in Group B. For, example, The words in Group A may all be alike because they are all <u>white</u> or the words in Group B may all be alike because they are all <u>sour</u>, or they may be in Group B because they are all <u>animals</u>. You should find the reason or the rule for placing each word in either Group A or Group B.

On your answer sheet is the number of the words. I will write the word for that number on the board. Suppose #1 was LEMON. Don't write anything down for a minute. You could guess that it goes in either Group A or Group B. You would write your guess in the GUESS column. Suppose you guessed that LEMON was in Group A. Then I'll tell you what group LEMON actually goes in. You write the correct answer that

I give you in the second column. Then you write down the reason or the rule why LEMON should be in that group. For lemon you may guess the rule "Sour things in A" or "Yellow things go in A", or "Citrous fruit goes in A". Just write your rule in one or two words each time.

Then I will give you the next word. You'll have 10 seconds to guess or figure out if it is in Group A or B. Then I'll tell you the correct answer. DO NOT GO BACK AND CHANGE OR FILL IN THE ANSWER IN THE GUESS COLUMN AFTER I HAVE GIVEN THE ANSWER. If you didn't guess, leave that column blank; it's better if you guess though. After you write down the answer I've given you in Column 2, I'll ask you "Why?" or "What rule can you use to tell you which cards go in pile A or in pile B?"

Let's do an example problem. On your answer sheet put your name, etc. Beside the word Problem write Example. All right, here is the first word. "Flea". (On the Blackboard E writes "1. Flea") I'll help you with this first word, Flea goes in A. Write A in the first column. (Pause) "Why?" Do you have any reason or a guess why it should go in A? (Allow ten seconds). (Erase the word) "The second word is CONCRETE." (Write "2. Concrete" on blackboard). "Alright, the correct answer is B. Why do you think Concrete goes in B?" (Allow ten seconds). (Erase that word and continue with example problem). (Continue example through the 6 words. On the first repetition, leave the words on the board for use in taking up the example problem. When it is understood by all begin actual test using the identical procedure. "Any questions?"

Name: ______________________ Date: __________

Problems: ___________________ Teacher ____________

Word Number	Guess	Correct Answer	REASON
1.			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

The two words we are looking for are______ and ___

13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

The two words we are looking for are____ and_____

25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			

The two words we are looking for are_____ and____

EXPERIMENT II

INSTRUCTIONS FOR THE CARD GROUPING TEST

"Put your name and your teacher's name on the top of your answer sheet. I am going to put some cards with words on them in front of the class. It is your job to try and form as many different groups of these words as possible. That is, you are to try and find as many different ways of grouping the cards as possible.

"For example, suppose these cards are put up:

kitten tiger dog wolf

"You may group them in several ways such as (Record on blackboard)

1. cat family - kitten, tiger.
2. wild animals - tiger, wolf.
3. words with "o" in them - dog, wolf.
4. there are many other ways that you could group them.

"In each case you must name the group, for example, cats. There must be at least two words in each group. Ignore any smears or irregularities in the printing, concentrate on what is written on the cards. Form as many groupings as you can. You have ten minutes for each problem. Are there any questions?"

EXPERIMENT II

INSTRUCTIONS FOR THE TRAINING PROCEDURES

Children will be brought in three at a time and assigned, one to each instructor. Children will spend 5 minutes on each problem before going to next problem.

1. Check to make sure if subject is in Group II or Group III.

2. Instructions (given individually) "The task we are doing here requires you to sort the cards into two piles A and B very much like we did in the classroom (or here on previous days)".

GROUP II RULE-FOLLOWERS (Subjects to be reinforced for following the rule).

1. Require Ss to pick up cards two at a time. They need not put these two cards into different piles, however.

2. Let subject make up his own rule for sorting the first time.

3. Make sure you understand the rule so you can reinforce properly before you let subject begin. After this do not discuss the problem at all.

4. When he places the card in accordance with the rule say, "Right", etc., and record a check on the answer form. If wrong, say "Wrong", have the subject change the position of the card, and record an (X).

5. When subject finishes, re-order the cards.

6. For the next sortings, the instructor provides the rules, for example:

For Set 1 Non-Verbal

Sort 1. Subject provides the rule, record it. If subject wishes, he may change his rule.

Sort 2. Instructor provides the rule: "All cards with athletes with players name at the top of the card go in A."

Sort 3. Instructor provides the rule: "Cards with some action and yellow on them go in A."

<u>GROUP III RULE-SEEKERS</u> (Subjects to be reinforced for making up new rules).

1. Subjects required to pick up cards two at a time, look at them and decide on some rule that could be used to place the cards.

2. Reinforce subjects' behavior by saying, "Very good", etc., for each <u>new</u> rule. Record it. Try to get three rules (at least one new one) for each pair of cards.

3. If subject pauses for more than 15 seconds, mark a _________, and suggest a new rule to him from the list provided. Record the rule. Make sure the subject understands.

4. Continue until the 5 minute time limit has espired, then go on to the next problem.